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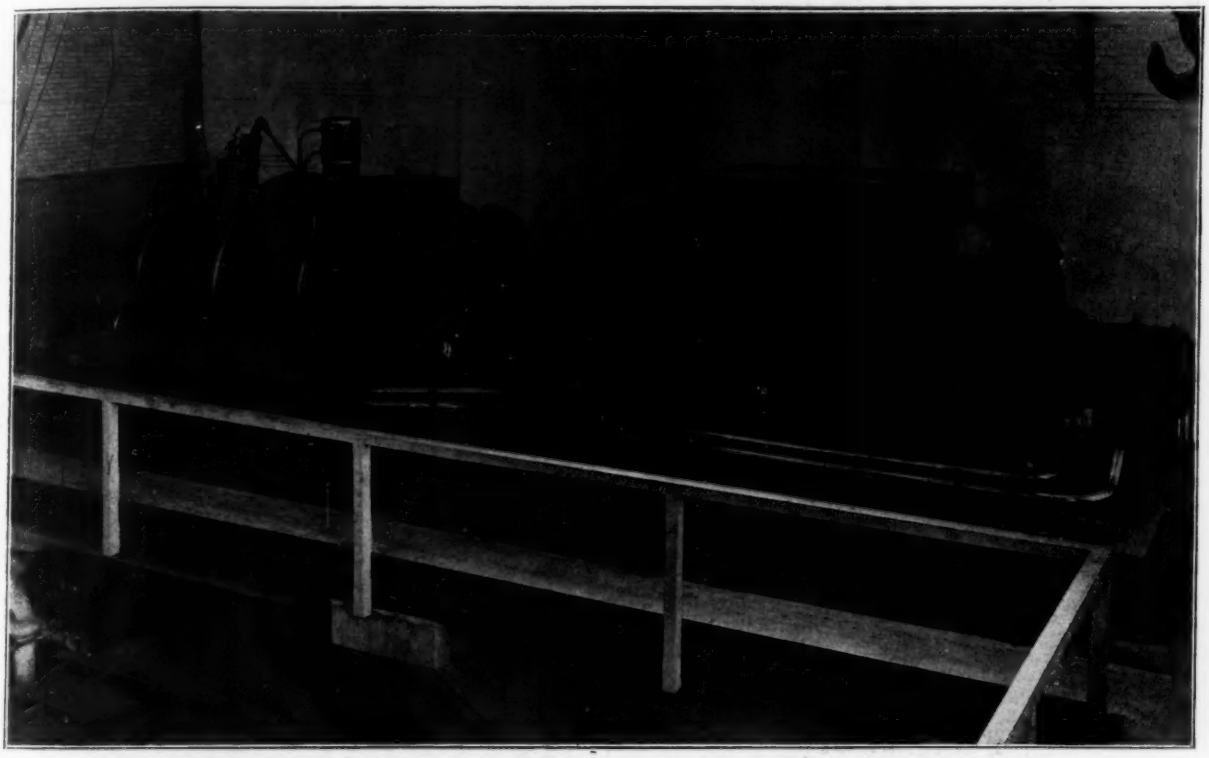


Fig. 1.—Horizontal 6000-kw. Turbogenerator at Sheboygan Plant of Eastern Wisconsin Electric Company.

Features of Three-Phase-Two-Phase Generating Station

Addition to Eastern Wisconsin Electric Company's Sheboygan Plant Comprises Interesting Installation and Operating Features

DURING last year the Eastern Wisconsin Electric Co. placed in service a large extension to its power plant at Sheboygan. The original capacity of the plant was 2250 kv-a., 2-phase. The additional capacity is 6000 kw. 3-phase, obtained from one 6000-kw. turbogenerator, whereas the original generating capacity was obtained from turbogenerators and reciprocating units.

The extension to the Sheboygan plant was made by extending the existing building and erecting an additional stack. The problem was to install 6000 kw. in a minimum of floor space of 50 by 90 ft. Work commenced in July, 1917, and the station was in operation in July, 1918. The condition of the foundation was such that piles were required. Altogether 604 35-ft. wooden piles were sunk. The Sheboygan plant, located on the banks of the Sheboygan River, Wis., is finished in red brick on the exterior, and yellow glazed brick on the interior.

BOILER ROOM.

The boiler room is an extension of the existing boiler room. Two 502-hp. Stirling boilers are installed, each served by an underfeed stoker of 90 sq. ft. grate area. Forced draft is furnished by an engine-driven blower, common to both stokers. The air or draft is automatically regulated by a damper regulator. Mechanical soot blowers are installed in the passes of each boiler, there being 5 units per boiler, each with 19 jets. Boiler feed-water is automatically regulated and measured by V-notch graphic recording and integrating meter. Boilers are equipped with non-return valves. Blow-down valves are in duplicate, their outlets being piped to the sewer. The blow-down

is not measured. All steam and hot-water lines are covered with heat insulating covering. Each boiler is equipped with an efficiency meter; an Orsat is used for

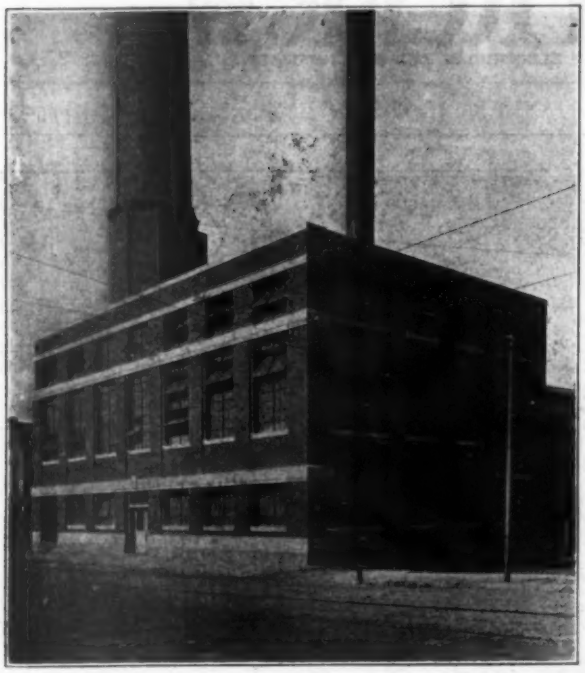


Fig. 2.—Exterior View of Addition to Sheboygan Central Station.

taking CO_2 readings, for which a gas sampling tank is installed. Stack temperatures are measured.

A separate hopper serves each boiler, the capacity of each being about 100 tons. The present stack, which has sufficient capacity to care for an eventual capacity of 20,000 kw., is a Custodis stack, 10-ft. flue lined with firebrick well above the breeching, and 200 ft. in height. The breechings are also lined with firebrick.

Coal is brought in by road, there being no trackage facilities on the side of the Sheboygan river on which the plant is located, 5-ton trucks being used for this purpose. Dumped from truck to bin, it is then passed

Fig. 3.—Underfeed Stokers.

through a crusher when necessary, which is driven by a 25-hp. induction motor, thence by conveyor to the individual stoker hoppers. Coal is weighed in the boiler room as it goes from the hopper to stoker by a self-registering scale. Ashes are taken out by cable cars, motor driven.

A 1280-gallon surge tank is installed on the roof for holding the condensate overflow or water from the city supply. This surge tank is piped to the heater through a V-notch meter to boiler feed pumps and boiler.

Turbine Room.

The turbine room is at the rear of and at the same level as the boiler room, and partitioned by a brick wall. Boilers and turbine are connected by a 10-in. welded steel header.

The turbogenerator is a 6000-kw., 1800-r.p.m., horizontal 7-stage machine, operating at 200-lb. steam pressure without superheat. Although no superheat is at present used, provision is made for the installation of superheaters in the boilers. The generator has a rating of 6000 kw. at 80% power-factor, 3-phase, 4000

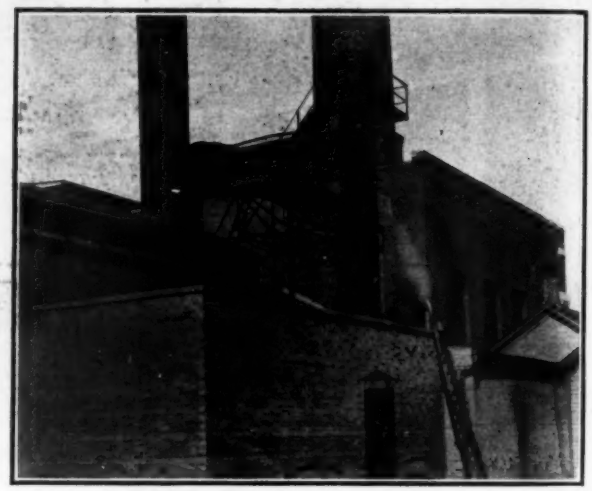


Fig. 4.—Coal-Handling Apparatus.

volts when star connected, with a maximum amperage of 1084 amperes.

The condenser into which the steam exhausts from the turbine is of the surface type, having 12,000 sq. ft. It is installed beneath and somewhat to the side of the turbine, in the condenser and auxiliaries pit. The circulating pump, which has a capacity of 12,500 g.p.m. under a 25-ft. head at 425 r.p.m., may be driven by a 100-hp. squirrel-cage induction motor or through a Falk reduction gear by a 110-hp. turbine operating at 3200 r.p.m. The hotwell or condensate pump is driven by the same units. The makeup pump is driven by a 7½-hp. induction motor. The circulating water passing through the condenser is screened by an intake screen of six sections. Vacuum is measured by both thermometer and pressure gauge.

There is space in the turbine room for another turbogenerator similar to the one already installed, which would make the total generating capacity 12,000 kw. A 40-ton crane covers the turbine room floor. All steam lines and connections are on one side of the building; all electrical conductors and connections on the other side. All station power and lighting conductors are installed in conduit, no wires being left exposed. Moreover, all conduit pull boxes, outlets

and cabinets are exposed to view except where passing through walls, floors, etc.

The 6000-kw. 3-phase generator operates in parallel with the 2250-kw. in the old station. As this older equipment generates 2-phase energy, provision had

Fig. 5.—Surface Condenser.

to be made for interchange of energy between the two sections of the power plant. This has been done by connecting the two through a bank of Scott-connected autotransformers.

Although intended to be a star-connected generator, the 6000-kw. machine has its windings delta connected and generates 2300 instead of 4000 volts. The ends of the generator windings are brought out directly beneath the generator (Fig. 7) and carried in a duct to the generator bus chamber, which is intended to be 4-wire, 4000 volts. From this bus, which is duplicate, the main supply goes direct to the autotransformers which change the energy from 3 to 2 phase. The Scott-connected autotransformers are rated at 195 kw. and are installed in a chamber below the level of the turbine floor as shown in Fig. 6. These are removed by taking up a reinforced concrete slab in the turbine room floor with the crane, which is also used for picking up and moving the autotransformers.

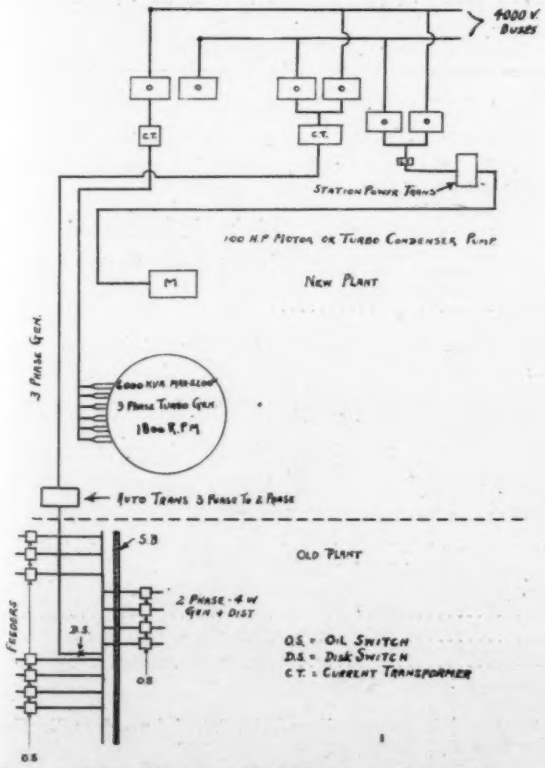


Fig. 6.—Wiring Diagram of Old Plant and New Extension.

The generator leads, connecting generator windings to bus, are of 5/32-in. varnished cambric, 750,000 cir. mil cable, designed for 7500 volts. There are two of these per phase. The cables are carried in a cable duct by porcelain cleats on 8-in. centers supported from an iron pipe frame. The generator leads pass through two current transformers, one for the relays and one for the measuring instruments, then vertically upward to the generator bus chamber, on the same level as the turbine floor.

In the bus or switch room all conductors and circuit-breakers are carried by open steel work, of channel iron. The generator buses are made up of two 5 by ¼-in. copper strips. The generator tie connec-

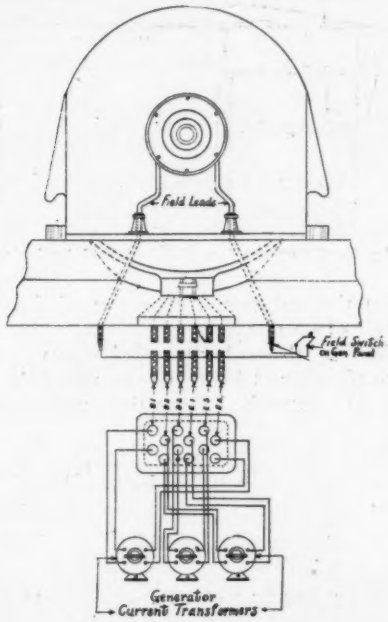


Fig. 7.—Generator Leads.

tions are composed of two 1,000,000-cir. mils cable per phase.

The operating gallery and switchboard is on a gallery above the level of the turbine floor and immediately above the control and bus structure, this latter being on the same level as the turbine. The arrangement of the generator buses is shown in the accompanying diagram, the two generator buses, their circuit-breakers, and the switchboard and operating gallery above. (Fig. 9).

The switchboard is of black oiled slate, and consists of panels for controlling the generator, exciters, storage battery, transformers, auxiliaries, station lighting and power. Provision is made for an additional generator, also for a 66,000-volt transmission line to Fond du Lac, which is about 45 miles away. No voltage higher than 440 volts reaches the switchboard. At the rear of the board are carried the two exciter buses, of copper strip. A battery charging motor-gen-

erator set is located at rear of switchboard, as are also the field rheostats.

The generator is protected by time-limit relays,

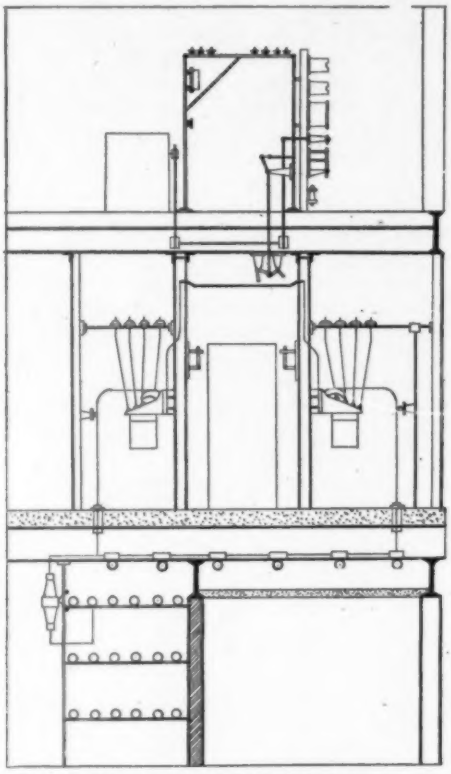


Fig. 8.—Cross-section of Electrical Galleries.

as are also the autotransformers used for changing from three to two phase.

Distribution throughout Sheboygan is 2-phase 4-wire, the phases not being interconnected. Lighting and power are furnished from the same circuit. It is the intention to eventually change over the distributing system to 4-wire 3-phase. It is for this reason that the new unit is a 3-phase machine. A large number of

Fig. 9.—Switchboard.

power customers are using 2-phase motors, but all new customers are having 3-phase motors installed, in readiness for the eventual change to 3-phase distribution. This means that all the newer power customers are supplied through Scott-connected transformers, for transforming the 2-phase of the system to 3-phase at the service. When the change is made the distributing system will be 4-wire.

Station lighting is in duplicate, namely from the system normally, and from the storage battery in emergency. The lighting is composed of 4 300-watt nitrogen lamps for the turbine room, and one 500-watt unit supplied from the storage battery, this latter being sufficient to light the turbine floor in emergency. The smaller lamps scattered around the station are connected some to the system and some to the storage battery.

PRINCIPAL EQUIPMENT AT ADDITION TO SHEBOYGAN POWER PLANT

Equipment.	Type.	Size.	Application.	Operating Conditions.	Manufacturer
1 Turbogenerator	Horizontal Steam	6000 kw., at 80% p-f.	Main unit	Turbine, 7-stage, 1800 r.p.m., 200 lb.; generator, 4000 volts, 60-cycle, 3-phase.	Allis-Chalmers Mfg. Co.
2 Boilers	B.&W.Stirling	502 hp.	Main steam to turbine	.....	Babcock & Wilcox.
2 Stokers	Side inclined underfeed	Type E	Boiler furnaces	.....	Combustion Engineering Co.
2 Blowers	.....	5 units of 19 jets each	Soot removal	.....	Diamond Power Specialty Co.
1 Fan	Sirocco	.....	Forced draft	Driven by either of two engines.	American Blower Co.
1 Stack	Custodis	200 ft. high, 10 ft. inside dia.	.....	.....	.....
1 Condenser	Surface	12,000 sq. ft.	For main turbine	29.45-in. vacuum obtained with 75° F. water.	Allis-Chalmers Mfg. Co.
1 Pump	Centrifugal	12,500 g.p.m.	For condenser circulating water	425 r.p.m. turbine driven through 3200/425 reduction gear by 110 hp. turbine. Also driven by 100 hp. induction motor.	Allis-Chalmers Mfg. Co.
1 Heater	Open	150,000 lb.	Feed-water	Metered through V.-notch recording and graphic Cochrane meter.	Harrison Safety Boiler Co.
1 Pump	Plunger	7x12 in.	Feed-water	.....	.....
2 Regulators	Copes	.....	Boiler feed	.....	Northern Equipment Co.
Hoist, Conveyor and Crusher	.....	.....	Coal handling	.....	R. H. Beaumont Co.
Pipe Covering	.....	.....	.....	All steam and hot water lines, boiler taps and drums, etc.	H. W. Johns-Manville Co.

Conservation of Heat Losses from Pipes and Boilers

Complete Detailed Method of Calculating and Solving Heat Losses—Economic Solution to Practical Applications—Abstract A. S. M. E. Paper

By GLEN D. BAGLEY

Engineer, Mellon Institute of Industrial Research.

THE purpose of this paper is to present a more complete and detailed method of solving the problems involved in the calculation of the heat losses from bare and covered pipes and the economic problems encountered in the practical application of coverings. The factors in the economic calculations are: the cost of the heat, the cost of the covering, the size of the pipe, the temperature of the pipe, and the temperature of the atmosphere. It is necessary to consider all these factors together in order to obtain a correct result.

The data contained in the paper are a part of the results obtained in an investigation conducted for the Magnesia Association of America by the Mellon Institute of Industrial Research.

It is generally recognized that the losses from bare pipes and boilers are considerable, but the real magnitude of these losses is little appreciated. The fact that the loss from 1000 sq. ft. of exposed surface at 100 lb. per sq. in. steam pressure amounts to over 300 tons of coal annually is sufficient justification for serious consideration of the subject.

Heat Losses from Bare Surfaces.

In a study of the conservation of losses, the first important fact to be considered is the actual value of the losses from bare surfaces. It is often considered that the loss from any bare surface is 3 B.t.u. per sq. ft. per hr. per deg. F. temperature difference between the surface and the surrounding air. This value is correct for some special cases, it is by no means generally so. Most investigators have confined their measurements to one size of pipe at one temperature difference. Both size of pipe and temperature difference have an important effect on the value of this constant. Paulding in his book on Steam in Covered and Bare Pipes has worked out the theory of heat losses from bare pipes. The curves, Fig. 1, indicate Paulding's values, while the dotted curves and the points give the results of various experimental tests.

It seems that Paulding's curves give the best average values for use in calculating heat losses. They show that the constant may vary from 50% below 3 B.t.u. per sq. ft. per hr. per deg. F. to values far above it. At 500° temperature difference, often attained with superheated steam, the constant increases to double this value for the smallest size of pipe. In some chemical plants steam is used at temperatures of 1100° F. The importance of using very thick insulation at these temperatures is easily judged from the rate at which the loss is increasing at 500° F. It is to be noted that these values are all considerably higher than the values given in Kent for losses from bare surfaces.

Heat Loss from Insulated Pipes.

The next important point in a consideration is the value of the loss after the pipes are insulated. In the apparatus used in determining these values at the Mellon Institute, the case of the heater, shown in cross-section in Fig. 2, consisted of three pieces of 3-in. pipe, the middle section being 3 ft. long and each end section 1½ ft. long. The sections were connected by heat-insulating disks of asbestos board and each end section was provided with a hemispherical cap of cast iron. Inside of each section was an electric heater made by winding resistance wire on a frame of asbestos boards. The wires were finely spaced and close to the inner surface of the pipe.

Results of tests made on five different makes of

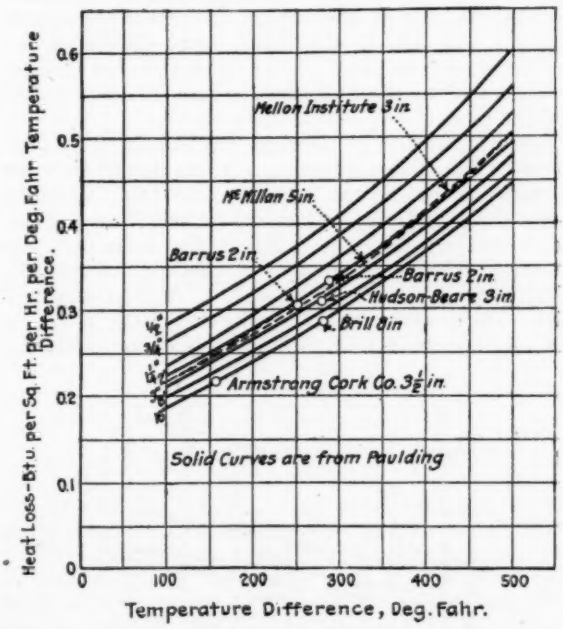


Fig. 1.—Heat Loss from Bare Pipe.

magnesia, in 1-in., 2-in. and 3-in. thicknesses, are shown in Fig. 3. These curves are all corrected for slight variations in thickness so that they are the true curves for the thickness given. Fig. 4 gives a comparison of the losses from a bare pipe with the losses through coverings 1 in., 2 in. and 3 in. thick. The contrast is very striking. The efficiency increases with the temperature as the loss from bare pipe increases much more rapidly in proportion than the loss from covered pipe.

Method of Conducting Tests.

Two standard 3-ft. sections of pipe covering were applied as shown and the ends covered with plastic. This placed half of each section and a joint over the middle section of the heater, a condition exactly sim-

ilar to actual practice. The currents in the different heaters were adjusted until the temperatures shown by the thermocouples attached to the surface of the pipe were alike on both middle and end sections. The coverings were dried out for several days until conditions

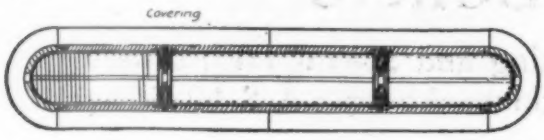


Fig. 2.—Cross-Section of Heater with Covering Applied.

became constant, as shown by hourly readings. The average of three consecutive constant readings was used to calculate conductivity. The power input was read on an accurate wattmeter and the temperature of the pipe by copper-constantan thermocouples peened into the surface. Since the end sections of the pipe were adjusted to the same temperature as the middle, there could be no flow of heat in a direction parallel to the axis of the pipe. This obviated the necessity for any kind of end corrections in connection with the conductivity measurements. To obtain the conductivity of any covering in B.t.u. per sq. ft. per hr. per deg. F., it was only necessary to convert the power input to the middle section in kilowatt-hours to B.t.u. per hr. and divide by the area of the surface of the middle section in square feet, and by the temperature difference between the air and pipe. The temperature of the air was measured by thermometers suspended several feet from the pipe.

The temperature of the pipe was measured by copper-constantan thermocouples. It was found that the variation of individual samples from the standard curves of the American Chemical Society was so great that it was desirable to calibrate the thermocouples before use. This was done by the boiling-point method, which proved very satisfactory. A Siemens and Halske suspension-type millivoltmeter with a resistance of 889 ohms was used in connection with the

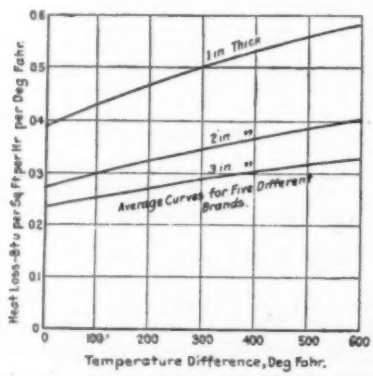


Fig. 3.—Heat Loss Through 85% Magnesia Coverings on 3-in. Pipe.

thermocouples to measure the temperatures. This apparatus made it possible to take a large number of readings quickly and accurately.

Calculation of Heat Losses Through Coverings.

The theoretical calculation of losses through coverings on flat surfaces is quite simple, but the problem of curved surfaces is much more difficult as the effect of the increased cross-section and surface area must be taken into account. Since conductance is directly proportional to cross-sectional area and inversely proportional to length of the path, the increment of heat loss is

$$H = \frac{2\pi K\,(T_1 - T_2)}{\log_e \frac{R_2}{R_1}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where

H = heat loss in B.t.u. per hr. per ft. length of covering.
T_1 = temperature of surface of pipe in deg. F.
T_2 = temperature of surface of insulation in deg. F.
R_1 = radius of pipe in inches.
R_2 = outer radius of insulation in inches.
K = conductivity of the insulating material in B.t.u. per sq. ft. of cross-section per in. thickness per degree F. temperature difference per hr.

The loss through any pipe covering can be worked out by the use of this equation providing *"K"* is

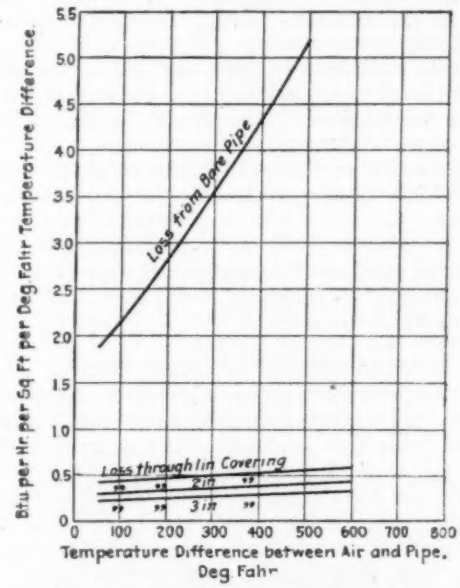


Fig. 4.—Heat Losses from 3-in. Pipe with 85% Magnesia Covering, and When Bare.

known. K varies with the temperature and must be obtained from an experimental curve giving the value at different temperature differences above room temperature. Fig. 5 gives the curve for *"K"* obtained during this research. It should be emphasized that this kind of curve is the only fair basis for comparison of the heat-insulating value of the different kinds of coverings, as all variables due to small differences in thickness, to different sizes of pipes on which tests were made and to different surfaces or room conditions are eliminated. These curves take into account only the conduction through the material as they are based on temperature measurements at the inner and outer surfaces of the insulating material and not on the temperature at the outer surface of the canvas covering or in the air.

Temperature difference between the outer surface of the insulating material and the temperature of the ambient air is a definite function of the heat transmitted per sq. ft. of the outer surface of the covering and of the kind of protective material used over the in-

sulation. Fig. 6 gives a curve showing this relation for the canvas covering as ordinarily used for this purpose. This curve was developed by L. B. McMillan at the University of Wisconsin and has been checked during this investigation. To use Formula 1 for a pipe covering in still air, an estimate of the heat

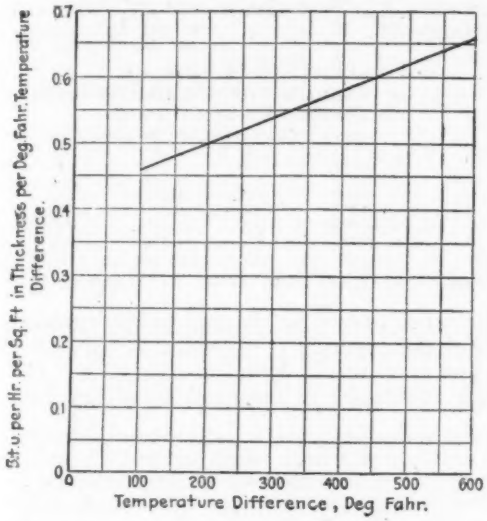


Fig. 5.—Absolute Conductivity of Magnesia Plotted Against Temperature Difference at Surface of Insulation.

loss per sq. ft. of the outer surface of the canvas covering must first be made. From Fig. 6 an estimate of the temperature beneath the canvas can then be made. Knowing this temperature and the temperature of the pipe, the term $(T_1 - T_2)$ of the formula is determined and the loss calculated. If this checks fairly well with the estimate of the loss from the outer surface, the calculation can be considered to give the proper value of heat lost. If not, the estimated loss from the outer surface must be changed according to the indication of the calculation and the calculations repeated until estimated and calculated losses check. This cumber-

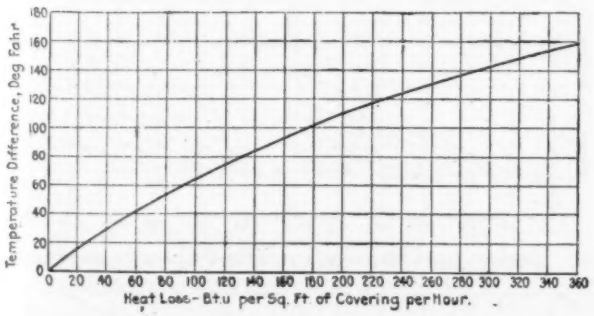


Fig. 6.—Temperature Difference Between Inner Surface of Canvas Covering and Room for Different Heat Losses.

some process is necessary because of the complicated nature of the flow of heat through the compound insulation composed of the insulating material itself, the protective covering and the effect which the surface finish has on the radiation of heat from the outer surface of the covering.

In case it is desired to compute the loss per sq. ft. of pipe surface instead of per lineal ft. of covering, the formula becomes

$$H = \frac{K\,(T_1 - T_c)}{R_1 \log_e \frac{R_2}{R_1}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Table 1 gives the value of the term $R_1 \log_e \frac{R_2}{R_1}$. The physical meaning of the figures in this table is the equivalent thickness on a flat surface of the given thickness in the given size of pipe. For example, a 3-in. thick covering on a 3-in. pipe is equivalent to a covering 1.75-in. thick on a flat surface.

An investigation was made to determine the distribution of temperature about a covering in still air. The results obtained show that no considerable error is made by assuming equal temperature distribution at the surface of the insulation in making the calculations.

Effect of Air Currents on Heat Losses.

Some tests have been made and others are in progress to determine the effect of wind velocity on bare and covered pipe losses. The apparatus used to determine this effect consisted of a 35-in. Sturtevant blower driven by an 8-hp. direct-current motor which furnished a blast of air for a wind tunnel. Apparatus used for testing pipe coverings was arranged inside of the tunnel so that the axis of the pipe coincided with

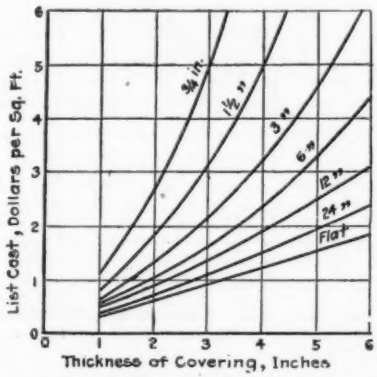


Fig. 7.—Cost Curves for Different Sized Pipes.

the axis of the tunnel. This caused the air to travel parallel to the axis of the pipe and gave a condition similar to that encountered in locomotive practice.

The first test was made with a 3-in. thick magnesia covering on the test pipe, a temperature difference of 460° F. between the pipe and the wind, and a wind velocity of 30 m.p.h. Under this condition the loss was 0.430 B.t.u. per sq. ft. of pipe surface per deg. F. temperature difference per hr. Under normal conditions of still air, the loss was 0.302 B.t.u., an increase of about 40% due wind velocity. From a theoretical consideration of the question, it can be shown that the maximum possible increase of loss due to wind will be reached when the temperature below the surface of the canvas covering on the magnesia is reduced to the temperature of the wind itself.

Fig. 6 shows the temperature beneath the canvas for any condition of loss in still air. When calculations are made for exposed pipes, the loss should be calculated both by use of this curve as explained before and by using the temperature of the pipe and the temperature of the air for T_1 and T_2. By comparing the loss in still air and the maximum loss which may

be caused by wind, an idea of the probable increase due to exposure can be obtained and extra thick insulation applied accordingly.

Permanency of Insulating Qualities of Coverings.

The last important point in considering pipe covering is permanency of insulation value. Tests were made on several old magnesia coverings. In the case of a 1-in. thick covering which had been 8 years in service at the Armour Glue Works, Chicago, the con-

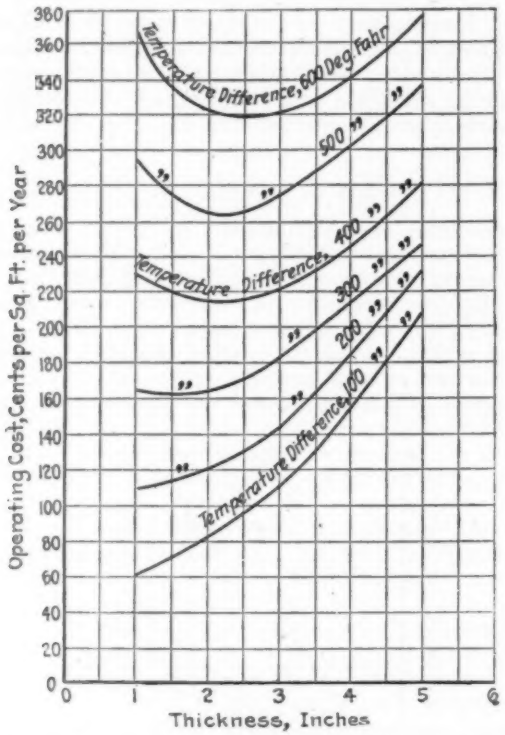


Fig. 8.—Curves for ¾-in. Pipe—Steam Cost, 80 Cents per 1,000,000 B.t.u.

ductivity was found to be slightly lower than the average of the new 1-in. coverings tested, showing that no deterioration in service had taken place. Tests on several sections which had been saturated with oil showed much lower insulation values than new coverings. The damage was permanent and shows that care should be used to protect coverings from oil while in service.

Initial Cost of Coverings.

After considering the technical and theoretical side of heat losses from bare and covered surfaces, the next point is the economic side of the problem. In most cases the result desired is the maximum net saving of money for any given condition. If the covering cost were nothing, the proper thickness would be limited only by the requirements of space available, as each increased thickness would result in some slight increased saving in heat. In a practical case where the covering has a finite cost, a point is soon reached where increased cost of the covering would be greater than the additional saving effected. Determining this point is what interests the user of coverings, as it is at this point that the maximum net saving is accomplished.

Fig. 7 shows how the list prices of coverings vary with the thickness. By means of these curves the cost per sq. ft. of surface covered can be determined for any thickness desired, and the annual fixed charges due to the covering calculated. After considerable investigation, it was decided that 20% of the list price of the covering would be allowed as the cost of application, and 13% of the total cost as the annual charges (6% interest, 5% depreciation and 2% insurance and miscellaneous).

TABLE 1—EQUIVALENT THICKNESS ON A FLAT SURFACE OF VARIOUS-THICKNESS COVERINGS ON DIFFERENT-SIZED PIPES.

Pipe size, In.	Thickness of covering, In. 1	2	3	4	5
¾	0.560	0.823	0.897	1.130	1.240
1½	0.679	1.073	1.350	1.570	1.740
3	0.790	1.332	1.750	2.080	3.360
6	0.878	1.565	2.135	2.620	3.040
12	0.925	1.740	2.460	3.030	3.680
24	0.960	1.843	2.680	3.400	4.150

Operating Expenses Due to Heat Losses.

The other cost to be charged to the operating expenses of the covering is the value of the heat losses. The previous work done on measuring the loss through 15 samples of magnesia furnished the neces-

TABLE 2—THICKNESS OF 85 PER CENT MAGNESIA FOR MAXIMUM NET SAVING.
(Thickness in Inches. S = Standard Thickness.)

Coal at $2 per ton.

Size pipe, in.	Hot water, 175° F.	Steam, 5 lb.	Steam, 100-200 lb.	200 lb. 150° F. superheat.	200 lb. 300° F. superheat.
¾	S	S	S	S	S
1½	S	S	S	S	S
3	S	S	S	1½	2
6	S	S	S	2	2
12	S	S	2	2	2
24	S	S	2	2	2
Flat	⅞	1½	2	3	3½

Coal at $4 per ton.

Size pipe, in.	Hot water, 175° F.	Steam, 5 lb.	Steam, 100-200 lb.	200 lb. 150° F. superheat.	200 lb. 300° F. superheat.
¾	S	S	S	1½	2
1½	S	S	1½	2	2
3	S	S	2	2	2
6	S	S	2	2	2
12	S	S	2	2	2
24	S	S	2	4	4
Flat	2	2	3	4	4½

Coal at $6 per ton.

Size pipe, in.	Hot water, 175° F.	Steam, 5 lb.	Steam, 100-200 lb.	200 lb. 150° F. superheat.	200 lb. 300° F. superheat.
¾	S	S	1½	2	2
1½	S	S	1½	2	2
3	S	1½	2	3	3
6	S	2	2	3	4
12	1½	2	3	4	4
24	2	3	3	4	5
Flat	2½	3	4	5	5½

Coal at $8 per ton.

Size pipe, in.	Hot water, 175° F.	Steam, 5 lb.	Steam, 100-200 lb.	200 lb. 150° F. superheat.	200 lb. 300° F. superheat.
¾	S	1½	1½	2	3
1½	S	1½	2	3	3
3	1½	2	3	3	4
6	1½	2	3	4	4
12	2	2	3	4	5
24	2	3	4	5	6
Flat	2½	3½	4½	5½	6½

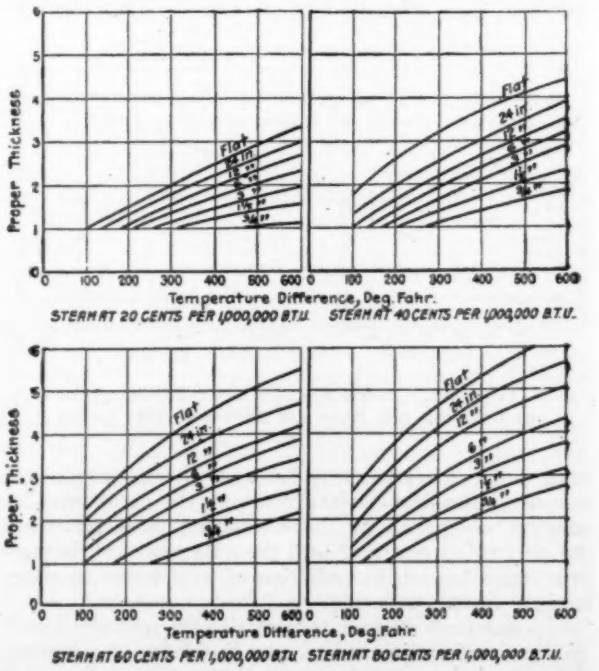


Fig. 9.—Thickness of 85% Magnesia for Maximum New Saving.

TABLE 3—COAL SAVED BY 85 PER CENT MAGNESIA COVERING 1 IN. THICK.

Steam pressure.	Saturated 5 lb.	Saturated 10 lb.	Saturated 50 lb.	Saturated 100 lb.	Saturated 150 lb.	Saturated 200 lb.	200 lb. pressure with 100° superheat.
Steam temperature, deg. F....	228	240	298	338	366	388	488
B.t.u. loss per hr. per sq. ft. bare pipe	367	409	625	802	937	1058	1735
B.t.u. loss per hr. per sq. ft. of pipe covered with 85% magnesia	69	76	105	126	142	153	210
B.t.u. saved per hr. per sq. ft. by covering pipe with 85% magnesia	298	333	510	676	795	905	1525
Tons (2240 lb.) coal saved per 10,000 sq. ft. per year of 8760 hr. by pipe covered with 85% magnesia	1190	1330	2080	2700	3180	3620	5650
Cars of coal saved per year, as above, at 40 tons per car....	30	36	52	68	80	90	140

Coal efficiency taken at 14,000 B.t.u. per lb. with boiler efficiency at 70%.

sary data for calculating the loss in heat units. After the heat loss was determined, it was necessary to convert it into dollars and cents. It was assumed that the coal cost is 75% of the cost of steam, that 1 lb. of coal as burned will evaporate 7 lb. of water from and at 212° F., and that each pound of steam contains 1000 B.t.u. above the feed-water temperature. The value of the heat losses was calculated for seven sizes of pipes, five temperature differences between pipe and

TABLE 4—MONTHLY COAL SAVING, IN DOLLARS AND CENTS, BY THE USE OF 85 PER CENT PIPE COVERING, STANDARD THICKNESS, PER 100 LIN. FT. OF STEAM PIPES.

Size of pipe, in.	5 lb. steam pressure.	10 lb. steam pressure.	50 lb. steam pressure.	100 lb. steam pressure.	150 lb. steam pressure.	200 lb. steam pressure.	200 lb. steam pressure, 100° superheat.
½	1.44	1.58	2.20	3.28	3.66	4.11	6.80
¾	1.72	1.89	2.87	3.70	4.26	4.89	8.03
1	2.11	2.30	3.56	4.80	5.35	6.04	10.00
1¼	2.52	2.74	4.22	5.52	6.50	7.25	12.20
1½	2.86	3.10	4.73	6.14	7.29	8.17	13.70
2	3.53	3.74	5.86	7.63	8.93	10.11	16.80
2½	4.25	4.39	6.95	9.07	10.55	11.90	19.90
3	5.00	5.33	8.30	10.90	12.60	14.30	23.82
3½	5.72	6.22	9.60	12.40	14.40	16.32	27.23
4	6.50	7.06	10.60	14.05	16.40	18.40	30.85
4½	7.30	7.69	11.80	15.35	17.92	20.25	34.00
5	7.97	8.64	13.16	17.20	20.00	22.72	38.00
6	9.36	10.15	15.60	20.38	23.82	26.88	44.90
7	10.90	11.70	18.38	23.68	27.60	30.80	52.00
8	12.26	13.22	20.40	26.60	31.20	34.90	58.55
9	13.80	14.70	22.70	29.00	34.52	38.61	64.80
10	15.08	16.33	25.00	32.70	38.40	43.08	72.40
Flat surface, area 100 sq. ft., 1¼ in. thick	5.26	5.67	8.80	11.50	13.48	15.12	25.44

These savings are based on pipes carrying steam for 24 hr. per day, 30 days per month. Coal is figured at $5 per ton, delivered.

air, and four different costs of heat, both on the basis of a known cost per million B.t.u. and on a cost per ton of coal and the average conditions of steam generation given above. By making calculations both ways, the results are applicable to plants where steam costs are accurately known, also where accurate records are not kept.

By combining the fixed cost and the heat losses per sq. ft. per year, total operating expenses were obtained. With these obtained, it is a matter of picking that thickness giving the minimum annual operating expenses to obtain the proper covering to use. Evidently the thickness giving the minimum operating expense also gives the maximum net saving, as the loss from bare pipe is a constant under given conditions and the net saving is the difference between the operating expense and the loss from bare pipe.

METHODS AND COSTS OF THAWING WATER MAINS AND SERVICE.

Data on the 1917-18 experiences of 96 cities with frozen water mains and services are included in the report of a special committee of the New England Water Works Association. The methods employed by these cities in thawing are summarized in the following table:

	Mains, No. cities.	Services No. cities.
Electricity	36	31
Steam	8	8
Hot water	4	11
Electricity, hot water	5	24
Electricity, steam	5	6
Electricity, hot water, steam	2	10

One city reported that the blow torch was employed in thawing services; another city employed fire.

The cost of thawing with electricity per job varied from $20 to $1. A summary of the costs is as follows:

No. cities.	Reported cost.	No. cities.	Reported cost.
3.....	$20	10.....	$10
1.....	18	3.....	$8 to $10
3.....	$15 to $16	21.....	$5 to $ 8
3.....	12	6.....	$3 to $ 5
2.....	11	5.....	Less than 3

The cost of thawing with steam ranged from $4.50 to $75, the later figure being reported by Stamford, Conn. One city reported a cost of $5, one a cost of $17.70, one $20, one $9.41, one $7.63, one $4.50, and $7.50, one $6.50, one $16.50, and one $14.

The reported cost of thawing with hot water ranged from $2 to $20. Four cities reported the cost as being $2. One a cost of $2.67; three a cost of $3; five a cost of $4 to $5; three a cost of $5 to $6; one a cost of $11.20; one $14, one $17, and one $20. One city reported the cost as being 5 ct. per foot of pipe thawed.

Three cities reported on the cost of thawing by fire. In one case the cost was $11.16, in another $10.69 and in the third $10 to $30.

It is interesting to note that electricity is far and away the most used method for thawing water mains and services and that its cost averages the lowest.

No data are available as to the time required to thaw pipes electrically, but it is generally conceded that whether quicker or not, it is cheaper and eliminates digging up and allied troubles.

OKLAHOMA UTILITY CONVENTION ARRANGED FOR FEBRUARY.

Manufacturers' Exhibit to Be Prominent Feature of Annual Meeting.

The Oklahoma Utilities Association will hold its annual convention in Oklahoma City, Okla., Feb. 6, 7 and 8. The meeting this year promises to be especially interesting and many novel features have been arranged for the occasion.

One of these features will be an exhibition of articles and apparatus of interest to utilities by the various manufacturers. A limited amount of space will be available for exhibition purposes for which no charge will be made. Manufacturers of such apparatus who desire to be represented at the convention may reserve suitable space by communicating with J. O. Kammennan, Oklahoma Utilities Association, State National Bank Building, Oklahoma City.

Selecting Coal for Power Plant Use

Article Pointing Out Characteristics of Various Coals—Influence of Coal Upon Furnace-Chamber Proportions—Purchase of Coal

By ROBERT JUNE

Mechanical Engineer.

This article is the first of a series on power plant management. These articles will discuss the various important phases of power plant management, factors that affect efficiency and economy. The power plant manager or superintendent reading this series will obtain a consecutive series of informative articles that may be educative for many, and in any case will serve to remind of the many factors in power plant operation requiring consideration.

PROBABLY no single factor in the operation of an existing power plant, or the design of a proposed plant, offers such opportunities to effect economies as does the proper selection of coal—the adoption of the right fuel to the right equipment.

Classification of Coals.

Ninety-five per cent of the coal used in steam production falls in one of the four following classifications:

Anthracite Coal consists almost entirely of carbon and inorganic matters; it contains little, if any, hydrocarbon. Some varieties approach graphite in their characteristics and are burned with difficulty unless mixed with other coals. Good anthracite is hard, compact and lustrous, and gives a vitreous fracture when broken. It burns with very little flame, unless moist, and gives a very intense fire, free from smoke. As it is only available for steaming purposes in certain limited sections of the country, specific problems relating to its combustion will not be discussed, attention only being called to a principal objection to its use, i. e., no matter how carefully handled, it is liable to break up under the influence of the high temperature of the furnace when freshly fired, with consequent large losses of fine pieces through the grates to the ash pit. It must also be remembered that it requires at least 40% greater combustion space than does bituminous coal. On this account it should never be purchased for use in furnaces not designed for it.

Dry Bituminous Coals are the best of the bituminous variety for steaming purposes. They are hard and dense, black in color, but somewhat brittle and splintery. They ignite readily, burn freely, with a short, clean, bluish flame and without caking.

Bituminous Caking Coals swell up, become pasty and fuse together in burning. They contain less fixed carbon and more volatile matter than the free-burning grades. Caking coals are rich in hydrocarbon and are particularly adapted to gas making. The flame is of a yellowish color.

Long Flaming Bituminous Coals have a strong tendency to produce smoke. Some varieties cake, others do not, while burning. This coal is preferable for use under dryers, in cement kilns, etc., rather than for general steam-making purposes.

As a general proposition, the free-burning, dry bituminous coals of the West Virginia, Pittsburgh and Illinois districts are to be selected for the production of steam.

The Question of Size.

The selection of coal of a certain classification is not enough. The size of the coal influences the capacity of the boiler, owing to its effect on draft. With poor draft, fine coal cannot be burned in sufficient quantities to maintain the rated capacity. If thin fires are resorted to, the efficiency of the boiler is usually lowered by holes in the fire. Dust and very fine particles check the air flow or else pass up the stack unburned. Experience alone will show the size of coal best suited to individual operating conditions. After the proper size of coal has been determined, insistence should be made that all deliveries conform to this uniform size, particularly since coal of uniform size does not pack as badly as coal of mixed sizes.

Bituminous coals in the Eastern states are graded and sized as follows:

(a) Run of mine coal; the unscreened coal taken from the mine after the impurities, which can be practically separated, have been removed.

(b) Lump coal; that which passes over a bar-screen with openings 1¼ in. wide.

(c) Nut coal; that which passes through a bar-screen with 1¼-in. openings and over one with ¾-in. openings.

(d) Slack coal; that which passes through a bar-screen with ¾-in. openings.

(e) Run of mine; the unscreened coal taken from the mine.

(f) Lump coal; divided into 6-in., 3-in. and 1¼-in. lump, according to the diameter of the circular openings over which the respective grades pass; also 6 by 3 lump, and 3 by 1¼ lump, according as the coal passes through a circular opening having the diameter of the larger figure and over one of the smaller diameter.

(g) Nut coal; divided into 3-in. steam nut, which passes through an opening 3 in. in dia. and over 1¼ in.; 1¼-in. nut which passes through a 1¼-in. dia. opening and over a ¾-in. dia. opening; and ¾-in. nut, which passes through a ¾-in. dia. opening and over a ⅝-in. dia. opening.

(h) Screenings; that which passes through 1¼-in. dia. opening.

For maximum efficiency, coal should be uniform in size. As a rule, the percentage of ash increases as the size of the coal decreases. This is due to the fact that all of the fine foreign matter separated from the larger coal, or which comes from the roof or the floor of the mine, naturally finds its way into smaller coal. The influence of the size of screenings on the capacity and efficiency of a boiler in a specific case is illustrated in Fig. 1. The curves are plotted from a series of tests conducted with Illinois screenings on a 500-hp. B. & W. boiler, equipped with chain grates, at one of the stations of the Commonwealth Edison Co.

Coal must be adapted to the combustion space in

the furnaces, or the furnaces must be adapted to the coal, if waste is to be avoided. As the chemical composition of the coal enters into this problem, Table I is included.

Table I.

Class of coal.	Fixed carbon, per cent.	Volatile matter, per cent.	Heating value per lb. of combustible.
Anthracite	92.5 to 97	3 to 7.5	14,000 to 14,800
Semi-anthracite	87.5 to 92.5	7 to 12.5	14,700 to 15,000
Semi-bituminous	75 to 87.5	12.5 to 25	15,500 to 16,000
Bituminous Illinois..	50 to 60	35 to 50	13,500 to 14,800
Bituminous Pittsb'gh..	60 to 75	25 to 40	14,800 to 15,200

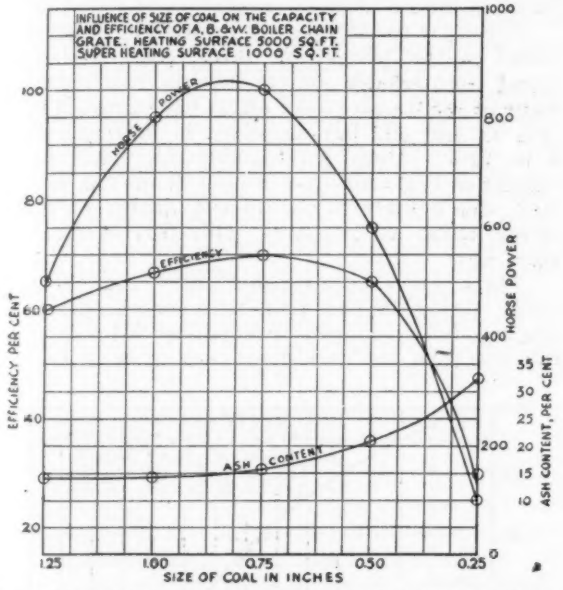

INFLUENCE OF SIZE OF COAL ON THE CAPACITY AND EFFICIENCY OF A. B. & W. BOILER CHAIN GRATE. HEATING SURFACE 5000 SQ. FT. SUPER HEATING SURFACE 1000 SQ. FT.
HORSE POWER
EFFICIENCY
ASH CONTENT
EFFICIENCY PER CENT
HORSE POWER
ASH CONTENT, PER CENT
SIZE OF COAL IN INCHES
1.25
1.00
0.75
0.50
0.25

Fig. 1.—Influence of Size of Screenings on Capacity and Efficiency of 500 hp. Boiler.

Coals of different composition require different sizes of combustion space. The chemical characteristics that are most likely to affect the size of the combustion space required for a given set of conditions are the quantity and quality of the volatile matter. The quantity of the volatile matter is shown by its percentage as determined by the proximate analysis. The quality of the volatile matter is indicated approximately by the ratio of volatile carbon to available hydrogen, and also by the oxygen content of the coal on a moisture and ash-free basis.

The principal chemical characteristics of Pocahontas (bituminous caking), Pittsburgh and Illinois coal are given in Table II.

Table II.

Item.	Pocahontas, per cent,	Pittsburgh, per cent.	Illinois, per cent.
Volatile matter in moisture and ash-free coal	18.05	34.77	46.52
Fixed carbon in moisture and ash-free coal	81.95	65.23	53.48
Volatile carbon in moisture and ash-free coal	8.55	20.47	26.22
Available hydrogen in moisture and ash-free coal	3.96	4.70	3.96
Ratio of available carbon to available hydrogen	2.16	4.35	6.6
Oxygen in moisture and ash-free coal	3.32	5.59	10.93

Table III gives the size of the required combustion space for the three coals and several sets of conditions, indicated by columns 1, 2 and 3.

Roughly speaking, under the same conditions, Pittsburgh coal requires about 20% larger combustion space than Pocahontas coal, whereas Illinois coal requires about 40% larger combustion space than Pittsburgh coal.

Table III.

Completeness of combustion, per sq. ft. of unde- veloped heat. (1)	Rate of combustion, lb. per sq. ft. of grate per hr. (2)	Excess of air, per cent. (3)	Cu. ft. of combustion per sq. ft. of grate area. * (4)	† (5)	‡ (6)
5	50	50	2.7	2.9	4.3
3	50	50	3.2	3.7	5.3
2	50	50	3.6	4.4	6.3
1	50	50	4.0	5.6	8.9
0.5	50	50	4.8	6.8	11.9
5	25	50	2.0	2.2	3.5
3	25	50	2.3	2.7	4.35
2	25	50	2.7	3.1	5.1
1	25	50	3.4	4.0	6.2
0.5	25	50	4.0	5.0	7.1

* Pocahontas, † Pittsburgh, ‡ Illinois.

That the size of the combustion space does not increase in direct proportion to the percentage of volatile matter in the coal is shown graphically in Fig. 2.

Both Figs. 2 and 3 are plotted from data given in Table III. The curve of the upper group of Fig. 3

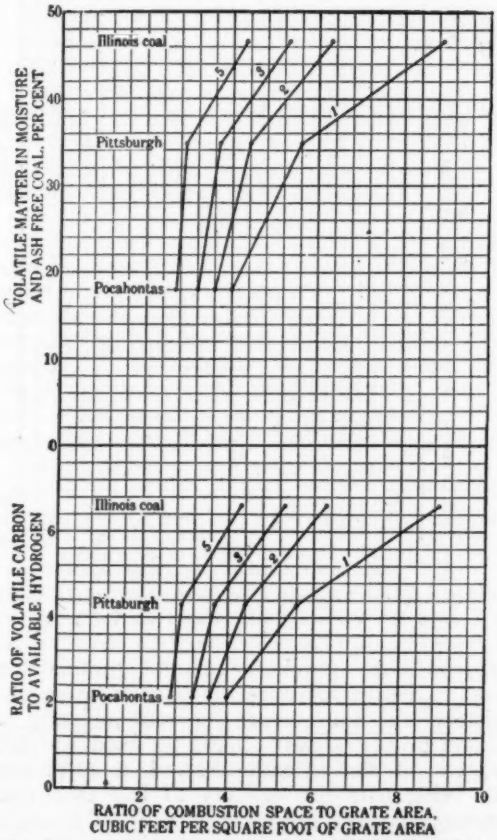

Illinois coal
Pittsburgh
Pocahontas
VOLATILE MATTER IN MOISTURE AND ASH FREE COAL, PER CENT
Illinois coal
Pittaburgh
Pocahontas
RATIO OF VOLATILE CARBON TO AVAILABLE HYDROGEN
RATIO OF COMBUSTION SPACE TO GRATE AREA, CUBIC FEET PER SQUARE FOOT OF GRATE AREA

Fig. 2.—Curves Showing Relation of Combustion Space and Grate Area to Volatile Matter in Coal.

gives the relation between the size of combustion space and the product of quantity times the quality of volatile matter from one degree of completeness of combustion indicated by the figure near each curve. It may be said that for complete combustion the size of the combustion space varies directly as the product of the quantity and quality of the volatile matter, as given in Table III.

To determine whether or not coal of the right combustion is being burned in a specific furnace, measure up the combustion space in the furnaces, have a de-

tailed chemical analysis made of a fair sample of the coal to be burned, and check them against the data given herein. If a new power plant is contemplated, be sure that the combustion space is designed for the coal which can be bought to best advantage.

Influence of Moisture.

Moisture in coal reduces the steaming efficiency. One per cent of moisture means a loss of 13 B.t.u. per pound of coal in superheated vapor in the smoke gases. It also decreases the capacity of the furnace, due to lowering the rate of combustion.

Although moisture is a great and uncertain variable and the producer can exercise no control over this

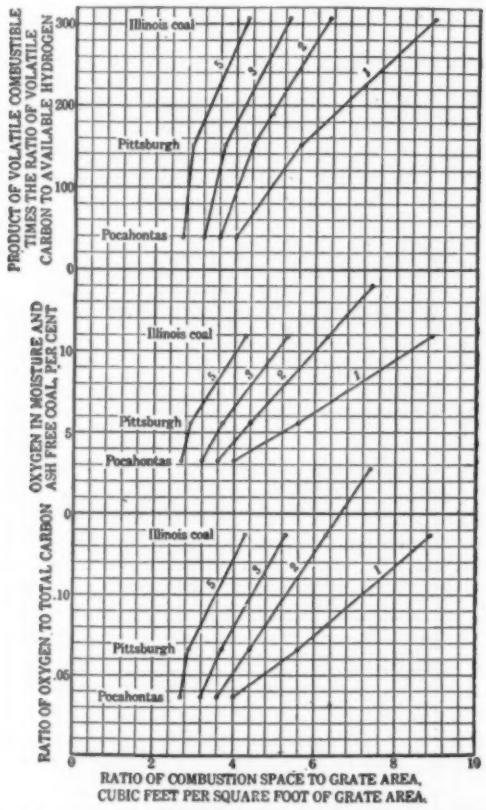

PRODUCT OF VOLATILE COMBUSTIBLE TIMES THE RATIO OF VOLATILE CARBON TO AVAILABLE HYDROGEN
OXYGEN IN MOISTURE AND ASH FREE COAL, PER CENT
RATIO OF OXYGEN TO TOTAL CARBON
Illinois coal
Pittsburgh
Pocahontas
RATIO OF COMBUSTION SPACE TO GRATE AREA, CUBIC FEET PER SQUARE FOOT OF GRATE AREA.

Fig. 3.—Curves for Proportion of Combustion Space and Grate Area for Various Coals, Based on Table III.

factor, still the purchaser should protect himself against excessive moisture, by stipulating an amount consistent with the average inherent moisture in the coal, and proper penalty should be fixed for delivery in excess of the amount allowed, a corresponding bonus being paid for delivery of less than contract amount.

The Ash Problem.

The amount of earthy matter or ash is of considerable importance in fixing the heating value of the coal, since the heating value of the combustible is practically constant. The effect of ash on the heating value of Illinois screenings as fired under a B. & W. boiler, with chain grate, is shown in Fig. 4. This value varies with the different types of boilers, grates and furnaces, but is substantially as illustrated. The amount of refuse in the ash pit is always in excess of the earthy matter as reported by analysis, except where the amount carried beyond the bridge is very large.

The maximum allowable amount of sulphur is sometimes specified, since some grades of coal high in sulphur cause considerable clinkering. But sulphur is not always an indication of clinker-producing ash, and a more rational procedure would be to classify a coal as clinkering or non-clinkering, according to its behavior in the particular furnace in question, irrespective of the amount of sulphur present. Ash fuses between 2300 and 2600° F. and if the formation of objectionable clinker is to be avoided, the furnace must be operated at temperatures below the fusing temperature. Several large concerns insert an "ash fusibility" clause in their coal specifications.

For many months the ash problem has been accentuated by the delivery of "dirty" coal. It has been found from reliable sources that the coal received in many of the largest power plants has increased by 5 to 10% in ash, and has decreased in heating value by 8 to 12%. Many good authorities state that the amount of coal consumed in their plants has increased 10%, due entirely to the inferior quality of coal received today as compared with that received two years ago.

There is no excuse for this "dirty" coal. The railroads, during the past year, have been burdened with hauling 30,000,000 tons of worthless dirt that anyone can dig from the back-door yard or have from the

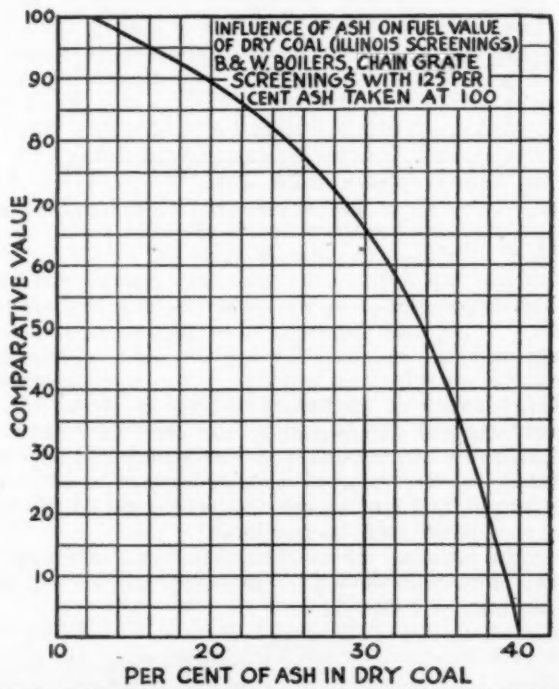

INFLUENCE OF ASH ON FUEL VALUE OF DRY COAL (ILLINOIS SCREENINGS) B.& W. BOILERS, CHAIN GRATE. SCREENINGS WITH 12.5 PER CENT ASH TAKEN AT 100
COMPARATIVE VALUE
PER CENT OF ASH IN DRY COAL

Fig. 4.—Influence of Ash on Fuel Value of Illinois Screenings: Used on Chain-Grate Stoker.

rock-pile, for the asking. These 30,000,000 tons of dirt have not only cost the power plant operator $120,000,000, but deprived him of 30,000,000 tons of real coal. The remedy for this condition is to be found in determined individual and co-operative insistence upon clean coal, and in the establishment of government coal-sampling stations to check the product of each mine as to quality and effectiveness of preparation.

Heating Value of Coal.

A discussion of the heating value of coal has been purposely left until the last, as this is the most obvious of all the factors entering into its selection.

The heating value of coal as determined by a sample burned in an atmosphere of oxygen does not give its absolute commercial evaporative power, since this depends largely upon the composition of the fuel, character of grade, and condition of operation, as already outlined. In large plants, where a number of grades of fuel are available, it is customary to conduct a series of tests with the different grades and sizes, and the one which evaporates the most water for a given sum of money, other conditions permitting, is the one usually contracted for. In designing a new plant, particular attention should be paid to the performance of similar plants already in operation, and the fuel and stoker should be selected which are found to give the best returns for the money.

However, there is no reason why the power plant operator should not know the number of B.t.u. in the coal which he puts into his furnace and every reason why he should know. The evaporation of so many pounds of water per pound of coal does not in and of itself indicate efficiency. The equivalent evaporation of 8 lb. of water per pound of dry coal would represent 70½% efficiency, if the coal contained 11,000 B.t.u. per pound, but the same evaporation with a coal of 14,500 B.t.u. heating value would represent only 53½% efficiency. Therefore, analysis of the heating units in the coal is essential to a knowledge of its value.

Purchase of Coal Under Specifications.

Engineers differ as to the specifications to be used in purchasing coal. Some favor a system of bonus and penalty on ash basis only; others favor a system on B.t.u. basis only. Much can be said on both sides, but undoubtedly the safest system is a combination of the two. With such a system, a proposal is made by the contractor, stating price, B.t.u. and ash content. Samples are taken each day of the coal furnished and a bonus is paid for B.t.u. content exceeding stipulation, the bonus being the same percentage of contract price that the excess B.t.u. is of the specification value. A corresponding deduction is made for coal falling below the specifications and in some cases a lower limit is set below which the coal may be refused at the purchaser's option, with the further stipulation that continued failure to supply coal within the specification limits will forfeit the contract.

For each per cent which ash falls below analysis a bonus is allowed. Generally an increase of 2% in ash content is allowed without penalty, above 2% a penalty is deducted according to a sliding scale.

It is only possible to be sure that the coal is being bought of fairly uniform characteristics by making an analysis of it as delivered. Two carloads of coal may look alike but the same may vary 10% or more in B.t.u. and a difference of 10% makes a difference of from 8 to 10% in the value of the coal.

All those power plant operators not in a position to make an analysis of the coal themselves have to do is to put an empty barrel in the boiler room and have the fireman throw in a part of a shovel of coal four or five times a day. At the end of a week or a month this coal should be taken out, mixed thoroughly, quartered, mixed again and quartered, until reduced to a size suitable to forward to the nearest testing laboratory. By mixing it, a representative sample, which will indicate pretty accurately the grade of coal that has been burned, will be obtained, and from this the efficiency of the boilers can be determined.

In entering upon a contract, it should be remembered that the important items to be considered in the specifications are:

(1) A statement of the amount and character of the coal desired.

(2) Conditions for delivery.

(3) Disposition to be made of the coal in case it is outside the limits specified.

(4) Correction in price for variation in heating value and in moisture and ash content.

(5) Method of sampling.

(6) By whom analyses are to be made.

In conclusion, it is not easy to select the proper coal for any given plant. But there is no factor in power plant operation which will so well repay proper attention.

(*To be continued.*)

PLATINUM PRODUCED IN ALASKA BRINGS HIGH PRICES.

Precious Metal Discovered in Widely Separated Regions—Lead and Zinc Output Decreases.

The production of platinum in Alaska shows that that metal is being produced in several widely separated regions. The first shipment of the metal out of that country was made in November, 1918, amounting to 133 oz., valued at $13,557—more than $100 per oz. Of this output, 105 oz. came from the Ketchikan district, 22 oz. from Seward Peninsula, and smaller amounts from Copper river region.

The domestic mine output of lead and zinc decreased in 1918, according to C. E. Siebenthal, in a statement just issued by the U. S. Geological Survey, Department of the Interior. The lead and the recoverable zinc of ores mined was approximately 563,000 tons and 627,000 tons, as compared with 651,156 tons and 711,192 tons in 1917. The lead available in the United States is 540,000 tons against 515,258 tons in 1917. The output of spelter from domestic and foreign ore was 525,600 tons, compared with 669,573 tons in 1917. Spelter from foreign ore decreased to 23,300 from 84,976 tons in 1917. The apparent domestic consumption of spelter was 440,000 tons, compared with 413,984 tons in 1917. The consumption figures of both lead and zinc include the metal shipped abroad for use of the American Expeditionary Forces. The average price of lead at New York was 7.6 cents a pound during 1918, and of spelter at St. Louis, 8 cents a pound.

ELECTRICAL DISTRIBUTION PROBLEMS DISCUSSED.

Empire State Gas and Electric Association Considers Many Phases of Problem.

A meeting of the electric distribution section of the Empire State Gas and Electric Association, held Jan. 17 in Schenectady, N. Y. At this meeting, which was well attended, a number of timely topics came up for formal as well as informal discussion.

The problem of providing work for partially disabled men has been anticipated by the association and considerable discussion took place as to the disposition of these men in line work. Transformer loading was another matter that came up, as was also that of transformer banks, the interconnection of feeders and the marking of poles.

Power and Torque in Electric Motors

Third of a Series of Articles Discussing the Principles of Different Types of Motors From a Common Standpoint —Power and Torque of Polyphase Induction Motors

By JUSTIN LEBOVICI

Lack of clear understanding of the action of alternating-current motors is due largely to failure to consider their principles on a common basis applicable to all classes of motors. In this series of articles Mr. Lebovici presents a discussion of power and torque of different kinds of motors based on the principles of the direct-current motor and of the static transformer. The fundamentals were reviewed in the first installments and applied to the direct-current motor and partly to the induction motor. The present installment continues discussion of the polyphase induction type. These articles should be read in connection with the author's two series of articles on alternating-current motors and windings published in our issues during 1916.

AFTER reviewing the fundamental principles of electric motors in the first article, we developed in the second one the formulas for the power input and power output and for torque in direct-current motors, and also discussed the development of torque and the relations during normal running conditions of the polyphase induction motor. We will therefore continue consideration of this latter type of motor.

(c) Analytical Derivation of the Equivalent Circuit.

It has been shown that along the axis of the stator phase S_1 the flux of mutual induction induces by transformer action the emf. E_p; similarly the leakage flux induces through its pulsation in the same axis the emf. $I_2 x_2$.

The total emf. induced by pulsation along the axis of this phase is, as expressed in complex quantities,

$$\dot{E}_p - j\dot{I}_2 x_2 \quad \ldots\ldots (29)$$

According to equations (21) and (24) we will generate through rotation the emf.

$$-f_r/f\,(\dot{E}_{sp} - j\dot{I}_2 x_2) \quad \ldots\ldots (30)$$

As previously shown, the emf. E_p combines with the emf's of rotation acting in the same axis to form a resultant which has to balance the secondary impedance drop along the axis under consideration.

We have then

$$\dot{E}_p - (f_r/f)\dot{E}_p + (f_r/f)j\dot{I}_2 x_2 = \dot{I}_2 (r_2 + jx_2)$$

or
$$(1 - f_r/f)\,\dot{E}_p = \dot{I}_2 [r_2 + jx_2 (1 - f_r/f)]$$

or
$$s\dot{E}_p = \dot{I}_2 (r_2 + jsx_2) \quad \ldots\ldots (31)$$

or
$$\dot{I}_2 = \frac{s\dot{E}_p}{r_2 + jsx_2} = \frac{\dot{E}_p}{\left(\frac{r_2}{s}\right) + jx_2} \quad \ldots\ldots (32)$$

Transferring from complex quantities to absolute values, we have

$$I_2 = \frac{E_p}{\sqrt{\left(\frac{r_2}{s}\right)^2 + x_2^2}} \quad \ldots\ldots (32a)$$

or identically the same equation as (27) or (28).

Expressing the secondary emf. and current in terms of the primary winding we obtain

$$\dot{E}_p{}^1 - \mu_e \dot{E}_p = -\epsilon_1 \quad \ldots\ldots (33)$$

and
$$\dot{I}^1{}_2 = \frac{1}{\mu_1}\dot{I}_2 \quad \ldots\ldots (34)$$

where μ_e and μ_1 are the ratios of voltage and current transformation, respectively.

For phase-wound induction motors having m_1 primary phases, m_2 secondary phases, W_1 turns per phase primary, W_2 turns per phase secondary, and fw_1 and fw_2 the winding factors respectively, we have

$$\mu_1 = \frac{m_1 W_1 fw_1}{m_2 W_2 fw_2} \quad \ldots\ldots (35)$$

$$\mu_e = \frac{W_1 fw_1}{W_2 fw_2} \quad \ldots\ldots (36)$$

The ratio of transformation for the rotor constants will be

$$\mu = \mu_e \mu_1 = \frac{m_1 W_1{}^2 fw_1{}^2}{m_2 W_2{}^2 fw_2{}^2} \quad \ldots\ldots (37)$$

For squirrel-cage motor substitute in formulas (35), (36) and (37) as follows:

$W_2 = 1/2$ $\qquad fw_2 = 1$ $\qquad m_2 = 2N_2/p$

where N_2 is the number of rotor conductors and p the number of poles in the stator.

We then obtain from (35), (36), (37)

$$\mu_1 = m_1 W_1 fw_1 p/N_2 \quad \ldots\ldots (38)$$

$$\mu_e = 2 W_1 fw_1 \quad \ldots\ldots (39)$$

$$\mu = 2m_1 W_1{}^2 fw_1{}^2 p/N_2 \quad \ldots\ldots (40)$$

Substituting in equation (34) we obtain

$$\dot{I}^1{}_2 = \frac{\dot{E}_1}{\left(\frac{r^1{}_2}{s}\right) + x^1{}_2} \quad \ldots\ldots (41)$$

The stator current is the vector sum of the magnetizing current

$\dot{I}_m = \dot{E}_1 (g_a - jb_a)$ and the load current $\dot{I}^1{}_2$

or (see Figs. 35 and 36)

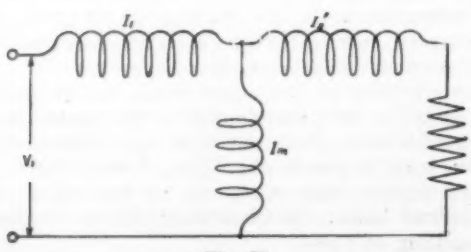


Fig. 35.

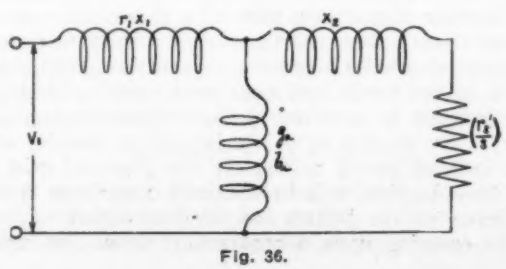


Fig. 36.

$$\dot{I}_1 = \dot{I}_m + \dot{I}'_2 \quad \ldots\ldots (42)$$

The applied emf. V_1 per phase

$$\dot{V}_1 = \dot{e}_1 + \dot{I}_1 (r_1 + jx_1) \quad \ldots\ldots (43)$$

Hence we come to the familiar equivalent circuit of a polyphase induction motor shown in Figs. 35 and 36. The above relations can be further transformed as follows:

From (41) $\dot{E}_1 = \dot{I}'_2 \dot{z}'_2 \quad \ldots\ldots (41a)$

From (42) $\dot{I}_1 = \dot{E}_1 y_a + \dfrac{\dot{E}_1}{\dot{z}'_2} \quad \ldots\ldots (42a)$

Substituting (41a) and (42a) in (43)

$$\dot{V}_1 = \dot{E}_1 \left(1 + \frac{\dot{z}_1}{\dot{z}'_2} + y_a \dot{z}_1\right) \quad \ldots\ldots (43a)$$

Neglecting $y_a \dot{z}_1$, we obtain

$$\dot{e}_1 = \frac{\dot{V}_1 \dot{z}_2}{\dot{z}_1 + \dot{z}'_2} \quad \ldots\ldots (43b)$$

Transferring from complex quantities to absolute values, we have

$$E_1 = V_1 \sqrt{\frac{\left(\frac{r'_2}{s}\right)^2 + x_1^2}{\left(r_1 + \frac{r'_2}{s}\right)^2 + \left(x_1 + x'_2\right)^2}} \quad \ldots\ldots (43c)$$

(d) Power in Polyphase Induction Motors.

The power input P_{1ph} into the rotor along the axis of the stator phase S_4 measured in watts is given in the same way as in the case of the direct-current motor (see equation 15) by the relation

$$P_{1ph} = E_p I_2 \cos (E_p, I_2) \quad \ldots\ldots (44)$$

Generally for m_2 secondary phases the total rotor input will be

$$P_1 = m_2 E_p I_2 \cos (E_p, I_2) \quad \ldots\ldots (45)$$

But equation (26) can be also written

$$S = f - (f_r/f) = E_p - (E_r/E_p) \quad \ldots\ldots (46)$$

and from Figs. 29 and 32

$$(E_p - E_r) \cos (E_p, I_2) = I_2 r_2 \quad \ldots\ldots (47)$$

or

$$E_p (E_p - E_r)/E_p \cos (E_p, I_2) = I_2 r_2$$
$$= s E_p \cos (E_p, I_2) \quad \ldots\ldots (48)$$

From (48)

$$E_p \cos (E_p, I_2) = I_2 r_2/s \quad \ldots\ldots (49)$$

Substituting (49) in (45) we have

$$P_1 = m_2 I_2^2 (r_2/s) = m_2 I'^2_2 (r'_2/s) \quad \ldots\ldots (50)$$

The power output P is given by the general formula (5)

$$P = m_2 E_r I_2 \cos (E_r, I_2) \quad \ldots\ldots (51)$$

From equation (46)

$$E_r = E_p (1 - s) \quad \ldots\ldots (52)$$

or $E_r \cos (E_r, I_2) = E_p (1 - s) \cos (E_r, I_2) \quad \ldots (53)$

but according to (49)

$$E_p \cos (E_p, I_2) = E_p \cos (E_r, I_2) = I_2 r_2/s \quad \ldots (54)$$

Substituting (54) in (53) we have

$$E_r \cos (E_r, I_2) = (1 - s) I_2 r_2/s \quad \ldots\ldots (55)$$

Substituting (55) in (51) we have

$$P = (1 - s) m_2 I_2^2 r_2/s = (1 - s) m_1 I'^2_2 r'_2/s$$
$$= (1 - s) P_1 \quad \ldots\ldots (56)$$

Equation (56) for the rotor output includes the bearing friction and the windage losses. Equation (50) for rotor input includes the power lost in heat developed in the rotor winding, as can be seen by subtracting (50) from (56)

$$P_1 - P = m_2 I_2^2 r_2/s - m_2 I_2^2 r_2/s + m_2 I_2^2 r_2 = m_2 I_2^2 r_2$$

To obtain the total input into the motor we have to add to the rotor input P_1 the power lost in heat in the stator winding $m_1 I_1^2 r_1$ and the iron losses.

The *torque* at the speed n is obtained from equation (56) by the application of equation (9).

When the induction motor runs free the current I_2 need be only small and in consequence the counter emf. E_r is nearly equal to the impressed emf. E_p. The speed n_1 at which E_r becomes equal to E_p or the frequency f_r equal to the frequency f is called the *synchronous speed.*

Hence equation (26)

$$s = (f - f_r) f$$

represents the drop in speed when the load comes on in percentage of the synchronous speed. This quantity has been given the name "slip."

It has become customary to express the torque of induction motors in "synchronous watts," a term which means the watts which would be required to give the torque if the motor were running at synchronous speed.

At synchronous speed $(1 - s)$ becomes 1, for $s = 0$, and the expression (56) for the torque in synchronous watts T_{syn} becomes identical with equation (50)

$$T_{syn} = m_2 I_2^2 r_2/s = m_2 I'^2_2 r'^2_2/s \quad \ldots\ldots (57)$$

Substituting the value of I_2 from equation (32a) or (41) we have

$$T_{syn} = \frac{m_1 E_1^2 \left(\frac{r'_2}{s}\right)}{\left(\frac{r'_2}{s}\right)^2 + x'^2_2} \quad \ldots\ldots (58)$$

Utilizing equation (43c), we obtain the synchronous torque in watts at any slip s

$$T_{syn} = \frac{m_1 V_1^2 \frac{r'_2}{s}}{\left(r_1 + \frac{r'_2}{s}\right)^2 + \left(x_1 + x'_2\right)^2} \quad \ldots\ldots (59)$$

According to (56) the output P

$$P = T_{syn\,(1-s)} = \frac{m_1 V_1^2 r'_2 \left(\frac{1 - s}{s}\right)}{\left(r_1 + \frac{r'_2}{s}\right)^2 + \left(x_1 + x'_2\right)^2} \quad \ldots\ldots (60)$$

In Fig. 37 are shown the torque-speed curves with different resistances in the secondary. In curve $r'_2 = 1$ the secondary resistance is small. In curve $r'_2 = 4$ the resistance is four times and in curve $r'_2 = 8$ the resistance is eight times greater than in curve $r'_2 = 1$. The maximum torque remains the same, but the speed at which the maximum torque occurs changes. In curve $r'_2 = 8$ it will be noticed that the maximum torque occurs at start and drops off rapidly as the speed increases. It is evident that the resistance r'_2 may be part of the rotor winding itself or may be

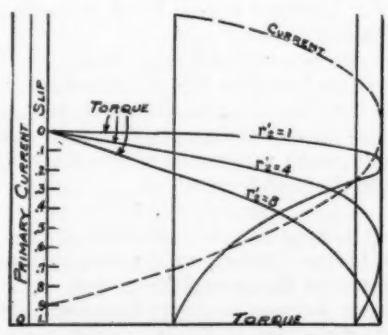


Fig. 37.

external to the rotor winding and connected to same by proper leads.

It is interesting to find the value of the maximum torque. The condition for maximum torque will be obtained by differentiating and equating to zero equation (58)

$$d T_{syn}/d s = 0 \quad \ldots\ldots (61)$$

The result of such differentiation is approximately

$$T_{syn\ max} = \frac{m_1 V_1^2}{2\left[r_1 + \sqrt{r_1^2 + (x_1 + x'_2)^2}\right]} \quad \ldots\ldots (62)$$

showing that: The maximum torque or pull-out torque of a polyphase motor is independent of the rotor resistance and varies inversely as the primary resistance as well as primary and secondary leakage reactance. The slip at which the maximum torque occurs is given by the equation:

$$s = \frac{r'_2}{\sqrt{r_1^2 + (x_1 + x_2)^2}} \quad \ldots\ldots (63)$$

To find the value of the maximum output, equation (60) may be differentiated and equated to zero or

$$d\,P/d\,s = 0$$

By neglecting certain small quantities the result may be shown as approximately

$$P_{max} = \frac{m_1 V_1^2}{2\left[(r_1 + r'_2) + \sqrt{(r_1 + r'_2)^2 + (x_1 + x'_2)^2}\right]} \quad \ldots\ldots (64)$$

We see that the maximum output or pull-out horse-

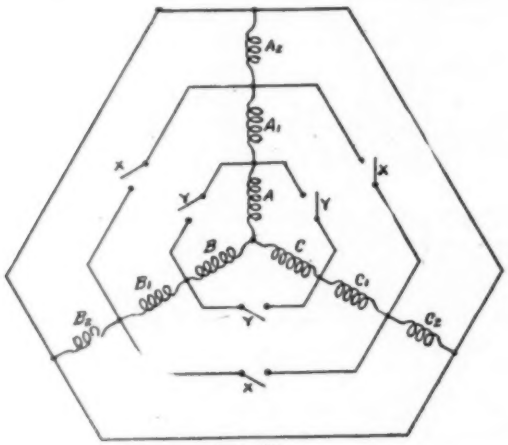


Fig. 38.

power of a polyphase induction motor is a function of the secondary resistance while the pull-out torque is not.

(e) Efficiency of a Polyphase Induction Motor.

The efficiency of the motor, as of any other machine, is the output divided by the input. The input equals the output plus the losses in the motor, or

$$\text{Efficiency} = \frac{\text{Output}}{\text{Output} + F_e + F + W + m_1 I_1^2 r_1 + m_2 I'^2_2 r'_2}$$

where F_e=iron losses,

F and W=friction and windage losses,

$m_1 I^2_1 r_1$=heat losses in the stator copper, and

$m_2 I'^2_2 r'_2$=heat losses in the rotor copper.

The maximum efficiency will occur (the same as in a transformer) at a point where the no-load losses are equal to the load losses:

$$m_1 I'^2_2 (r_1 + r'_2)$$

Thus it is seen that the efficiency of the polyphase induction motor depends to a very large extent upon the resistance of the secondary circuit.

(f) Starting Torque in Polyphase Induction Motors.

The starting torque T_{st} in synchronous watts (or, if we divide the value of the torque in synchronous watts by 746, in synchronous horsepower) is obtained from equation (59) if we make s=1. We have

$$T_{st} = T_{syn\ (s=1)} = \frac{m_1 V_1^2 r'_2}{(r_1 + r'_2)^2 + (x_1 + x'_2)^2}$$

but

$$\frac{V_1}{\sqrt{(r_1 + r_2')^2 + (x_1 + x_2')^2}} = I_k$$

is nothing else but short-circuited or locked primary current value at full voltage, for which we will use the letter I_k.

$$T_{st} = m_1 I^2_k r'_2 \quad \ldots\ldots (63)$$

In considering the best starting condition the current taken from the line at the moment of starting (A) and the watt-seconds used up during the starting period (B) ought to be considered in connection with the speed-torque curves shown in Fig. 37.

Limiting the starting current to K times full-load current, we have

$$I_k = K I_1 \quad \ldots\ldots (64)$$

and substituting (64) in (63)

$$T_{st} = m_1 K^2 I^2_1 r'_2 \quad \ldots\ldots (65)$$

We had before in (57)

$$T_{syn} = m_2 I^2_2 r_2 / s = m_1 I^2_1 r'_2 / s \quad \ldots\ldots (65a)$$

Combining (65a) with (65) and noting that in starting s=1, we can write

$$T_{st} = s K^2 T_{syn} \quad \ldots\ldots (66)$$

We will consider briefly the starting of polyphase

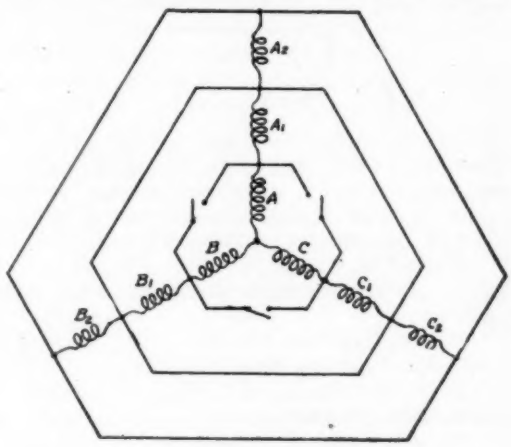


Fig. 39.

induction motors by the various methods in common use, assuming that, in order not to reduce the efficiency of the motor too much, the rotor resistance will be so chosen that the slip does not exceed 4%. In line with many central-station regulations we will limit the starting current to three times full-load current.

(a) Starting with primary voltage reduced by means of ohmic resistance in series with the primary winding.

Substituting in (66) s=0.04 and K=3, we obtain

$$T_{st} = 0.04 \times 3^2 T_{syn} = 0.36\, T_{syn}$$

or about one-third normal full-load torque in starting with three times full-load current taken from the line.

(b) Starting with primary voltage reduced by means of an autotransformer.

The autotransformer reduces the voltage at the motor terminals and the value of the locked current in the same proportion. The primary of the autotransformer will draw from the line less than the motor current in proportion to the reduction in voltage.

For a 50-hp. squirrel-cage motor with a locked current 6.8 times normal, we will obtain three times full-load line current on approximately 66% tap. The rotor current will be greater by the ratio of transformation or 4.55 times normal. For a full-load slip we obtain by substitution in (66)

$$T_{st} = 0.04 \times 4.55^2 \times T_{syn} = 0.8\, T_{syn}.$$

This is more than twice as much torque as by method (a).

(c) Primary voltage reduced by connecting the

primary winding in star for starting and delta for running. The number of primary turns in series between the lines is thus increased by 73%, the starting torque and starting current are cut down to one-third of their full-voltage values.

(d) Phase-wound rotor with external resistance inserted in the secondary by means of slip rings.

It can be seen from Fig. 37 that increasing the secondary resistance r^1_2 raises the starting torque until the starting torque reaches the pull-out torque; a further increase in resistance lowers the starting torque again.

In order to obtain the value of r^1_2 which would give the maximum torque at standstill, we have to make $s=1$ in equation (63) and we obtain

$$r^1_{2\,(s=1)} = \sqrt{r^2_1+(x_1+x^1_2)^2} \quad \ldots\ldots\ldots\ldots (67)$$

(g) Self-Starting Motor Shown in Fig. 38.

Many attempts have been made to combine the starting characteristics of the high-resistance rotor type of induction motor, in a motor having high efficiency when full load is reached. The following scheme has been very successfully applied in motors between 5 and 100 hp.

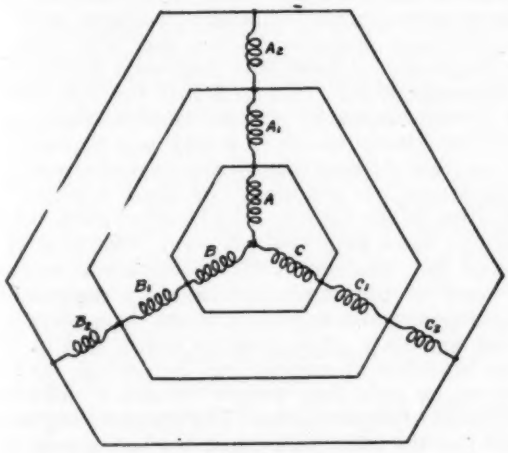


Fig. 40.

The stator in this motor is the same as in any standard polyphase induction motor. The rotor is phase wound. Each rotor phase is made in several parts A, A_1 A_2, as shown in Fig. 38. The wire used in sections A, A_1, A_2 is nonmagnetic, but the specific resistance of the wire used in section A is different from the specific resistance of the wire in sections A_1, A_2. In starting, the winding sections A, A_1, A_2, are in series, and their combined resistance so selected that the desired starting characteristics are obtained. After the motor reaches a predetermined speed a centrifugal switch closes the points x, x, x, in Fig. 38, the motor continuing to speed up with connections shown in Fig. 39, until the centrifugal switch operates again, closing switches y, y, y in Fig. 38 and the motor has reached its normal operating rotor connections shown in Fig. 40. In Fig. 40 the phases A, B, C; A_1, B_1, C_1; A_2, B_2, C_2 are connected to independent circuits giving a very low secondary resistance.

The speed-torque and speed-current curves during the period of acceleration are shown in Fig. 41.

(h) Heating of the Rotor Windings During the Starting Period.

The specific heat capacity of the metals used in the construction of squirrel-cage and phase-wound rotors are given in the following table:

Brass	0.094
Copper	0.094 to 0.101
Nickel	0.109
Tin	0.056 } Use in the form of alloys
Zinc	0.095

Calling W the weight of a certain part of the winding in lbs., t the temperature rise per second in degrees centigrade, c the specific heat capacity, the gram-calories generated in a certain portion of the winding is given by

$$c\times(W/2.26)\times t\times 1000$$

or, making on an average $c=0.094$, we can write

$$\text{Watts}\times 0.2388 = 0.094\,(W/2.26)\,t\;1000 \quad \ldots(68)$$

Calling W_{1b} the watts per pound or (Watts/W) we obtain from equation (68)

$$t = W_{1b}[(0.2388\times 2.26)\div(1000\times 0.094)]$$

or

$$t = W_{1b}/174 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (69)$$

Knowing the time necessary to bring the motor up to speed, and dividing the time to start into several periods, we can by repeated application of equation (69) find the temperature of the winding at the end of the accelerating period. The temperature t ought to be lower than the temperature which will affect the insulation or solder used in the rotor construction.

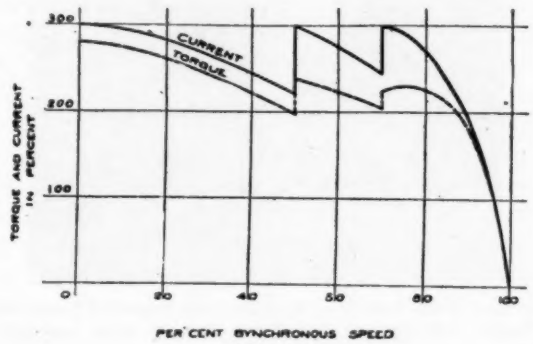


Fig. 41.

(To be continued.)

NEW YORK JOVIAN LEAGUE HOLDS ANNUAL MEETING.

The New York Jovian League held its annual meeting and luncheon on Jan. 7 in the Hotel McAlpin, New York City, President J. M. Wakeman presiding. Louis D. Gibbs, county judge of Bronx County, was guest of honor, and in his address regarding the vital questions and general business conduct incident to war conditions and the change to peace, he pointed out that the two important factors during the period of reconstruction would be co-operation and co-ordination. Those corporate interests which were unsuccessful and which are now struggling for existence were those which had aroused the enmity of the public. Judge Gibbs also proved beyond a doubt that the antidote of Bolshevism, in fact, the cure, is to treat labor fairly.

Preceding the address by Judge Gibbs, the following officers were elected for the ensuing year: President, James M. Wakeman; vice-president, James R. Pollock and Walter Neumuller; secretary, J. Wynne Jones; treasurer, Lawrence L. Strauss; directors, Arthur Williams, James R. Strong, James H. Betts, George Williams, Frederic H. Leggett and Frederick S. Hartman; publicity director, H. W. Casler.

GAS STREET LIGHTS REPLACED BY ELECTRIC LIGHTS.

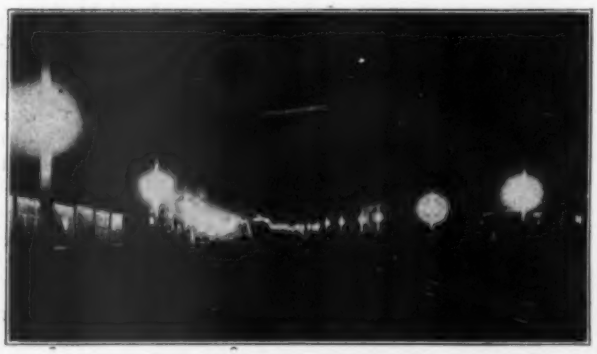
San Francisco Improves Lighting of Van Ness Avenue—Concrete Combination Trolley and Lighting Poles.

The City of San Francisco recently decided to replace the gas lights on Van Ness avenue with electric lights at the same time that the Municipal Street

Day View of Old Gas Lamp Post and New Concrete Combination Trolley and Lighting Pole Before Fixtures Were Installed.

Railway was being constructed on that avenue. As the construction of the railway required that trolley poles be installed along the curb, the Engineering Department designed the trolley poles to serve as electroliers as well as trolley poles. These poles are of reinforced concrete and consist of a simple shaft with ornamental top. In connection with the conduit which was installed for the trolley feeder cables, a line of electric light conduit was installed.

The old lighting system consisted of three triple-



Night View of New Lighting Along Van Ness Avenue, San Francisco, Cal.

top gas lamps per block from Market street to Vallejo street, giving a nominal candlepower not exceeding 500 per block. From Vallejo street north, the lighting system formerly consisted of only one electric arc lamp per block, giving actually 300 cp. per block.

Five hundred 250-cp. tungsten lamps, located 2 to the pole and 16 to the block, now give a total of 4000 cp. per block, in place of the 500 furnished by the gas lamps, and 300 by the old arc lamps. The lighting circuits are arranged so that the lamps on alternate poles may be extinguished when desired.

Under the old system of lighting it was dangerous for a pedestrian to attempt to cross the street because of the heavy automobile traffic. Now the entire street is flooded with evenly distributed light and the appearance of the street as well as the public safety has been greatly enhanced. The night view is actually much better than that shown in the accompanying cut.

ENGINEERS IN THE WAR AND AFTER—ELECTRIC ROAD TRAINS.

Engineers Have Come Rapidly to the Front—Electric Highway Trains to Facilitate Reconstruction.

Col. R. E. B. Crompton, in his recent presidential address to the Junior Institution of Engineers in London, England, discussed "What the War Has Done for Engineers, and the Part Engineers Have to Play in Reconstruction." He said that the war demands had greatly improved the status of the engineer in every department, whether it had been in the designing of new forms and of the organization of the manufacture of munitions, or their transport and utilization in the fighting line; in all of these the engineer had more than held his own. One year of war showed that nine-tenths of the work was essentially the work of the engineer. In every department of Government work, engineers found themselves forced to the top, their advice eagerly taken, and in all the great branches of engineering the natural leaders of engineering took their proper position as administrative heads of departments. The status of engineers in regard to the body politic had reached a point which it would have taken many years to reach if it had not been for the war. The war had been the crucial test between the workers and the talkers, and here, at any rate, the workers had won.

In considering the work to be done in connection with reconstruction, Colonel Crompton placed first in order of importance road construction, and this led on to the vehicles using the roads. He referred to the saving that could be effected by using road trains on the Renard principle, if and when the Government extended the electric supply to the whole of the rural districts. If and when road vehicles could be driven by power derived from a side wire by a trolley pole, very great economy and low dead weight of the propelling vehicles could be obtained, as the weight of the electric motor and its gearing was much less than that of the gasoline engine with its supply of fuel and cooling water, or in the case of the steam unit of the boiler and steam engine.

Colonel Crompton said his most advanced idea was that it would be wise to develop the use of electrically driven road trains, each train consisting of four three-axle vehicles. It would be possible to load each of these axles to 8 tons, or a total moving weight of train close on 100 tons, without the road crust being stressed in excess of what was now the case when a motor truck, with back axles loaded to 8 tons, passed over it at the same speed. The speaker said that he did not propose to avail himself of such extreme figures, but he thought that the subject of road trains, combined with electric driving, merited careful consideration.

Editorial Comment

Turbines and Some Phases of Central-Station Operation

IT WAS the central station, the concentration of large amounts of power in a given space and the economy of large units that such an arrangement made possible, that created the demand for the large steam turbines that have grown and grown in size to those of 70,000 kw. that exist today. And power applications other than central station have taken to the turbine as it became available and applicable to their requirements.

Steam turbine development has, however, made progress not only in the direction of larger capacities, some units of 60,000 kw. were placed in service and 70,000 kw. units were ordered during the last year, but also in the smaller units. Steam turbines of 7.5 kw. are now available for the many and varied applications such as main unit drive in the small plant, for the driving of auxiliaries such as pumps, fans, stokers and line shafts. The availability of the small turbine changes the complexion of the isolated plant situation entirely as it also offers the large power plant an excellent opportunity to adopt a desirable arrangement of auxiliaries by drive of motor and turbine that is at once flexible and economical.

One of the most noticeable facts of the last year was that a number of large steam turbogenerator units were installed by isolated or industrial plants. A number of steel mills and powder plants placed in service in their own plants turbogenerators of 15,000 and 20,000 kw., which it is understood are the largest individual units installed so far outside of central stations. Although these were perhaps exceptional cases, because of the heavy demands of the war, there is every reason to believe that the very large manufacturer using much power in his undertaking will tend more and more to utilize the steam turbine with its high efficiency and operating economy. It might be pointed out here that while the size of a steam turbine plays an important part in deciding upon the water rate or coal consumption per kilowatt-hour, the load-factor also plays a vital part; and the higher load-factors of the central stations as compared to the average isolated or industrial plant contribute to the economy of the former more than is generally appreciated.

The adoption of the steam turbine in large capacities, or small capacities even, by isolated plants brings up a problem that deserves consideration. A power plant of 10,000 kw. or more is one that the central station in the neighborhood may look upon with rivalry or with equanimity, as the case may be. But such a plant may in many cases be of considerable use, because making interconnection with the central station feasible and desirable.

The making of steel, or other industrial process, is an art in itself. Into this art or process enters the consumption of power. The production of electric power is also an art or science in itself, and only when so treated is it most economically obtained. Therefore, in these days of specialization one would rather be led to expect that the manufacturer of steel or whatever it is would be content to confine himself to the making of steel, leaving to the manufacturer of electric service the production, distribution and sale of power. Usually the steel manufacturer makes his own power because it is cheaper to do so. If it were cheaper to purchase it he would. The logical place for a power plant supplying a steel mill is usually at the steel mill, the center of gravity of the load, provided other conditions are favorable.

Central-station service today implies not necessarily one centralized station but rather generating stations conveniently and judiciously located at various load centers and so interconnected and their output co-ordinated that there exists a unified system of diversified load, straddled peak with higher load-factor and better utilized equipment than would obtain were each power plant of the system isolated and independent. It is these things that contribute so materially to the operating economy of central-station service. Would it not then be a logical conclusion, therefore, where a 10,000 or 20,000-kw. isolated plant exists in proximity to a central-station system, to suggest that the manufacturer of power—the central-station company—might to the advantage of itself and the manufacturer of steel or other commercial product, own or lease and operate such isolated plant? To do so would remove from the manufacturer the responsibilities and troubles that go with a power plant to whom the production of power is only a means to an end. With such a plant tied-in with the public utility system, the load-factor of the so-called isolated plant would in all probability be increased, resulting in increased economy and lower cost of operation and lower energy costs therefore. And there would be a further gain in that reserve capacity would be available for emergency or normal growth. Such an arrangement, where feasible, is advantageous alike to both parties and the country in general, because saving coal, reducing duplication of purpose and effort, and lowering cost of doing business.

The worst that can be said of many an isolated plant is that it is isolated. The economies that would accrue were it tied-in with other neighboring plants do not materialize. Many of these plants are, of course, not in first-class condition, are not scientifi-

cally operated, nor are operating conditions favorable. Interconnection tends to overcome all these things and improve matters generally. Production of power is an undertaking that requires, and deserves, specialization. A power plant located at the center of gravity of its load is often the logical solution. But such a power plant, if leased and operated by those specializing in the production of power, would prevent economy of operation being handicapped by lack of knowledge and absence of favorable circumstances. The war has proved that interconnection is not the monopoly of the utilities, but that utility and isolated plant can get together to mutual benefit. Let such instances multiply.

Reduction of Radiation Losses

THE loss of heat by radiation is a loss that is apt to assume greater proportions than realized in most power plants. The loss exists just as long as there is heat to be radiated, unless preventive measures are adopted. And because this loss goes on silently, invisibly, insidiously, makes it none the less real. That the loss of heat by radiation is sufficient justification for giving the matter of prevention serious consideration may be emphasized by mentioning that every 1000 sq. ft. of exposed surface, at 100-lb. steam pressure, results in a coal consumption of more than 300 tons of coal annually.

The reduction of radiation losses is a simple matter. It is a financial question of determining to what extent it is worth while to save heat lost by radiation. It is a matter of balancing the cost of heat lost against the cost of insulating exposed surfaces against that loss. The problem is one involving the cost of heat, the length of time the loss exists, and the cost of reducing the loss. It is not, therefore, a matter of eliminating radiation losses, which is scientifically as well as financially impractical, but of reducing them to an amount that pays. It does not pay to reduce your radiation heat losses to such an extent that the cost of doing so exceeds the cost of allowing that heat to be lost, unless there are other factors involved.

Because radiation losses are so easily reduced, they are classed as preventable. And no preventable loss should remain unprevented. And of the preventable losses, that by radiation is the one most easily overcome, and when once overcome, no other loss remains so long or so cheaply. In other words, money spent in the reduction of radiation losses is money well spent, and when once spent begins to save money without necessitating further expenditures to keep the investment sound.

Elsewhere in this issue appears a rather complete article by Glen D. Bagley on the "Conservation of Heat Losses from Pipes and Boilers." This article describes the results obtained by numerous experiments with covering exposed surfaces with various thicknesses of heat-insulating material. Data are presented showing the cost of such covering balanced against the cost of heat that would be lost were the surfaces not covered. Thus it is a simple matter of determining how far to go—to what extent it is profitable to reduce your radiation loss from boiler drums and tops, brickwork, steam and hot-water lines, etc.

As has already been pointed out, the reduction of radiation loss is a simple matter. No other loss can be so easily reduced, nor does it remain so for so long. Preventing loss from imperfect combustion necessitates eternal vigilance and capable watchfulness, for conditions are never long the same. Losses due to interference with heat transfer from the gases of combustion to the contents of the boiler never remain the same for long, for soot on the outside and scale on the inside of heating surfaces combine to lower efficiency and increase stack temperatures unless action is continually brought in play to overcome them. Air infiltration through warped doors, leaky and cracked brickwork is a condition that may come about at any instant, for a tight setting is susceptible to radical change. But radiation losses of exposed surfaces when once attended to are attended to, if not forever, for a long time. In Mr. Bagley's article an instance is given where a pipe covering that had been in service eight years was found to have suffered no deterioration in heat-insulating properties.

While it is true that pipe covering and heat-insulating materials if properly applied remain efficient for long periods without deterioration, it is also true that they may easily suffer mechanical injury because of their rather delicate composition. What is worth doing at all is worth doing properly, hence surfaces that are covered should be covered properly, which means protecting them where protection is indicated as advisable. Around the setting, above fire doors where the slice bar is used for cleaning fires and breaking up clinker damage may be done the pipe covering above. Where the traveling crane may be expected to raise and lower objects in close proximity to pipes is another place where proper protection seems worth while. In such cases canvas wrapping that normally suffices might be augmented with a wrapping of sheet iron soldered or strapped in place.

One fact brought out in Mr. Bagley's paper is that although magnesia pipe coverings show practically no deterioration in heat-insulating properties after years of service, provided no damage be done them, there is an exception. Magnesia that has become oil-soaked does suffer a loss of heat resistivity or its ability to insulate. This fact should be borne in mind and oil drippings or contact with sources from which oil can reach the magnesia should be avoided.

The radiation loss goes on as long as there is heat to be radiated. Because this loss is not spectacular or noisy like escaping steam but is instead invisible, silent and insidious there is a tendency to allow it to persist. To do so while adopting other fuel-saving measures such as instruments, etc., is equivalent to saving at the spigot and wasting at the bung.

Week's Events

Electrical Machinery Manufacturers Meet—Kansas Law on Indeterminiate Franchises—Carbon Brushes Discussed

ELECTRIC POWER CLUB HOLDS IMPORTANT MEETING AT CLEVELAND.

Electrical Machinery Manufacturers Discuss Foreign Trade, Standardization and Kindred Topics of the Times.

Closer co-operation with the Government on the part of electrical manufacturers and the possibilities of foreign trade were the two dominant features of the first day's session of the Electric Club, in semi-annual session at the Hotel Statler, Cleveland, Ohio, Jan. 13, 14 and 15. The attendance was the largest for some time, there being over 85 men present, representing 38 companies.

One of the pleasing features of the opening session was the enthusiastic and genuine vote of thanks tendered to C. L. Collens, president of the club, who during the war devoted a major portion of his time and energies in the service of the Government as chairman of the War Service Apparatus Committee of the electrical industry.

The first session's program included reports of the executive officers and standing committees, followed by addresses on "Industry's New Contact With Government," by Walter Robbins, and "Co-operation With the Government," by Gilbert H. Montague. At the afternoon session, following the report of the Club's Board of Governors, there was a symposium on foreign trade, in which papers were read as follows: "Combinations Under the Webb-Pomerene Bill," by Gilbert H. Montague; "The South American Situation," by Philip S. Smith; "General Assistance Offered by the Bureau of Foreign and Domestic Commerce," by W. M. Strachan; "The Tariff," by S. L. Nicholson. After a banquet in the evening, there were two addresses on "Terms of Payment," by L. W. Lyons, and "Contract Forms," by Hugh A. Brown.

The Electric Power Club, made up of manufacturers of electrical power machinery from all parts of the United States, has for its prime purpose the development and standardization of electrical machinery from the standpoint of technical design and only incidentally has to do with the commercial aspect of the electrical business. This week's session of the Club was one of special importance, in view of the reconstruction problems now facing all industries. At the session on Jan. 14 prominent men of the industry were present and discussed freely the outlook for the industry and its immediate problems.

Three facts were prominently brought out: First, that electrical machinery has not advanced in price level during the war in the ratio of costs of labor or cost of living. The electrical industry has not profiteered, and its price reactions from war levels will not be acute nor rapid. Second, there are few lines of industry in which the cost of labor is relatively so large a part of the total cost as this. The price reactions must turn largely, therefore, on what happens in the field of labor readjustment. It was the consensus of opinion of the meeting that no immediate sharp changes in labor costs are likely to occur, but that, on the contrary, wage reductions may not be expected until actual reductions in cost of living occur. Third, that it would be a serious mistake for the electrical industry to attempt to lower the price level of electrical machinery by lowering the standards of design and performance. Great emphasis was placed by several speakers on the international fame of American electrical equipment for reliability and efficient performance, and all member companies were urged not to jeopardize this reputation under any circumstances by impairment of design quality, even though the possible pressure for price reduction at this time might create a temptation to do so.

There is every probability of the electrical industry being one of the first to return rapidly to a peace footing of normal activity, as the absence of radical price inflation during the war gives the buying public confidence for the immediate resumption of peace buying on a large scale.

A more complete report of the meeting will be published in our next issue.

WESTERN ELECTRICAL INSPECTORS TO HOLD ANNUAL CONVENTION JAN. 28-30.

Post-War Problems Meeting Arouses Considerable Interest—Conservation by Standardization Principal Topic.

The fourteenth annual meeting of the Western Association of Electrical Inspectors will be held Jan. 28, 29, and 30 at the Hotel Sherman, Chicago. This meeting has been properly termed the "Post-War Problems Meeting" and the principal topic of discussion will be the need of conservation and the methods of accomplishing it. A tentative program has been arranged which promises a very interesting presentation of this and other subjects.

The meeting will open Tuesday morning with an address of welcome by a representative of the city government, to which C. K. Creigier, of Chicago, vice-president of the association, will reply. The members will then be addressed by President Frank L. Lucas, of Toledo. Following the presentation of various reports Dana Pierce, chairman of the Electrical Committee, National Fire Protection Association will explain the "Making of Electrical Rules." "The Validity of Ordinances Regulating the Sale of Electrical Devices and Materials" will be presented by Chas. W. Babcock, assistant city attorney of Milwaukee, and J. B. Mac Neill of the Westinghouse Electric & Manufacturing Co., will explain the "Economy of Small Capacity Circuit-Breakers."

At the afternoon session the principal subject, "Conservation by Standardization" will be presented by W. H. Merrill, president of the Underwriters'

Laboratories. This subject, which is of vital importance to everyone connected with the industry, will be followed by a discussion of probable influence of such conservation upon the industry by J. S. Milhoit, of the Cutler-Hammer Manufacturing Co., Milwaukee, and other speakers to be appointed by the Associated Manufacturers of Electrical Appliances. Dr. Morton G. Lloyd, electrical engineer of the Bureau of Standards, will then explain the scope of and the new work done on the new combined National Electric Fire and Safety Code.

A complimentary dinner to members will be given in the Morrison Hotel in the evening at which F. A. Barron, of the General Electric Co., Schenectady, will present a paper on "Time Lag in Motor Protective Devices." William H. Blood, Jr., vice-president of the American International Shipbuilding Corp., is also expected to be present and describe the many features of the Hog Island shipyards.

Wednesday morning will be devoted to the reports of special committees on subjects of interest to electrical inspectors. In the afternoon the members will visit the Underwriters' Laboratories, 207 East Ohio street, Chicago. For this occasion special tests of electrical fittings and material will be run and a fire test made of wired-glass windows.

Prior to the election of officers, Thursday morning a discussion of inspectors' problems will take place. Members are requested to present these discussions to the secretary, W. S. Boyd, 175 West Jackson boulevard, Chicago, in writing as far in advance of the meeting as possible. As the annual Automobile Show will be held in Chicago during the same week as the convention, the committee anticipating a great demand for hotel rooms, requests that members communicate as soon as possible with C. B. Giles, City Hall, Chicago, chairman of the committee on hotel arrangements, to insure suitable accommodations.

CITIES SERVICE COMPANY BUYS COLORADO PLANT.

Doherty Interests Secure Control of Western Light & Power Co. of Northern Colorado.

The Cities Service Co., affiliated with Henry L. Doherty & Co., has purchased control of the Western Light & Power Co. of Northern Colorado. Controlling interest was acquired from Westinghouse, Church, Kerr & Co. Directors of Cities Service Co. have ratified the negotiations and new directors have already taken charge of the company.

The power plant of the Western Light & Power Co. is located at a coal mine near Lafayette, Colo., and is equipped with automatic stokers and other machinery to save labor in handling its coal supply. The company furnishes light and power current for Boulder, Longmont, Loveland, Greeley, Fort Collins, Milliken, Fort Lupton, Brighton and other northern Colorado towns. The main offices are at Boulder.

Equipment improvements to cost $1,250,000 are being planned by the Doherty interests, according to a statement by Frank W. Frueauff in Denver. To raise the necessary capital to pay for needed improvements and lift the indebtedness, a reorganization of the Western Light & Power Co. is likely to be made. The Colorado concern has a bonded indebtedness of $2,300,000, due in five years.

"Expansion work cannot be started at once, but it will be got under way as soon as conditions justify and will be carried on as rapidly as possible. The last few years have been hard ones for this concern," said Mr. Frueauff, "and the new control does not mean smooth sailing right away. Rather this will probably mean reorganizing the company, and a lot of additional hard work. Eventually, we shall very likely build a tieline between the Western Light & Power Co. plant and our Denver plant—that of the Denver Gas & Electric Light Co."

KANSAS CITY JOVIAN LEAGUE TO HARMONIZE ELECTRICAL INTERESTS.

Annual Meeting Considers Further Development of Real Co-operation Between Different Electrical Interests in Kansas City.

At its first meeting of the year, held Jan. 7, the Jovian Electric League of Kansas City, Mo., took up the matter of greater harmony between the various electrical interests of the city. President Hand reported the action of the Club President's Round Table with regard to a more careful study of the relations between public utilities and the public interest, which was in opposition to a resolution condemnatory of the utilities. The league hopes to create a better feeling of harmony. That the Kansas City Light & Power Co. will probably get its new central station in operation this year offers an immediate reason for such coordination. The league has already brought into cooperation with other interests the manufacturers of farm lighting plants whose business in this territory would be helped by more aggressive marketing of electrical appliances. A satisfactory state of affairs exists between the light company and local electrical dealers and it is believed similar harmony can be effected between jobbers now selling at retail and the contractor-dealers. This depends, however, upon a marked increase in aggressive retailing of electrical devices by the latter dealers. The league will hold two meetings a month this year on account of the great amount of development work to be done.

LARGE CENTRAL-STATION COMPANY ADOPTS NEW NAME.

Kings County Electric Light & Power Co. Hereafter to Be Known as Brooklyn Edison Co., Inc.

Pursuant to a resolution adopted at a special meeting of the stockholders of the Kings County Electric Light & Power Co. of Brooklyn, held Dec. 18, the name of the company was changed Jan. 10 to Brooklyn Edison Co., Inc. This change was made merely for convenience and brevity for as with many other such companies, the new name has for some time been commonly applied to the company.

This company controls the Edison Illuminating Co. of Brooklyn and its entire property is leased and operated by the latter. The electric service for practically the entire Borough of Brooklyn is furnished by this company which had a generating capacity in 1918 of 111,250 kw.

RATE ADVANCE SUSTAINED BY OHIO COMMISSION.

The decision of the Ohio Public Service Commission has sustained the Alliance Gas & Power Co.'s contention that the ordinance passed in 1914 fixing the electric rates at 6 cents and 3 cents is confiscatory and the decision sustains the present rate being charged by the Alliance company.

KANSAS LAW MAY GIVE UTILITIES INDETERMINATE FRANCHISES.

Law Will Put Kansas Gas & Electric and Possibly Other Utilities Under Jurisdiction of State Commission.

A bill will be introduced in the Kansas Legislature this session providing that the Kansas Gas & Electric Co. be placed under the Kansas Public Utilities Commission, thus revoking all its present charters with some twenty cities and towns. These franchises, terminating at different times, have caused annoyance in conducting business which the bill would relieve. According to the present law no franchise may be granted in Kansas for longer than twenty years. The change would make them indeterminate, continuing as long as the company gave service satisfactory to the Commission and to the cities operated in. During the next five years the Kansas Gas & Electric Co. expects to expend about $12,000,000 in development and improvement, which expenditure would be made much easier were the question of franchises terminating at any time be eliminated. The bill has met with such favor that many organizations have urged that it be broadened to include other utilities than the Kansas Gas & Electric Co.

CARBON BRUSHES IN RELATION TO MACHINERY DESIGN.

Discussion of Brush Characteristics and Standardization Before British Electrical Engineers.

The English Institution of Electrical Engineers devoted one of its December meetings to discussion of a paper by P. Hunter Brown on carbon brushes considered in relation to the design and operation of electrical machinery. He included brushes made of carbon and of graphite, with or without the addition of various metals. He said that the characteristic properties of carbon rendered it a peculiarly suitable material for dynamo brushes. It was capable of withstanding high temperatures; it was a reasonably good conductor of heat and electricity; it was not unduly abrasive; and its "contact drop," although not high enough to cause excessive loss, was sufficient to render possible a fixed brush position.

A demand was not infrequently made for a universal brush, or at most two qualities, which would meet every case of commutating work, with a third quality for slip-rings. The requirements of modern machines, however, were too diverse and too exacting for such a thing to be practicable. Mr. Brown said that to secure satisfactory operation the problem might be stated thus:

"(*a*) In the case of slip rings the brushes must maintain uninterrupted contact with the rings and carry the current with minimum frictional and electrical losses. Distribution of current between the various brushes must be sufficiently uniform to prevent local heating, and the rate of wear of both rings and brushes must be kept within reasonable limits.

"(*b*) In the case of commutating machines the problem is further complicated by the fact that the brush, instead of running on a smooth continuous homogeneous surface, must run satisfactorily on a composite surface consisting of narrow copper strips separated by mica or air spaces. Furthermore, the brushes must possess the commutating characteristics necessary to give the required assistance in this direction, and must be capable of withstanding the unequal distribution of current which inevitably occurs in each individual brush."

The author then discussed the properties of carbon brushes. These properties must be studied individually and then collectively by running the brushes under actual operating conditions. By this means a definite relation could gradually be established between purely laboratory results and actual running performance. He considered in turn: specific resistance, friction, contact drop, hardness, abrasiveness, thermal conductivity, and inertia. The question of brush design (size and fittings) came next, after which reference was made to selection of grade (current density, peripheral speed, mica and slip rings); and to operation (angle, bedding, mixing grades, rate of wear, lubrication, and operating conditions). The author closed his paper with the following notes on standardization:

"From time to time this question, which is beset with difficulties, has been discussed in England in an informal way and at the present time definite recommendations are under consideration with regard to standard sizes of brushes for shipboard machines. In America greater efforts have been made in this direction. The Electric Power Club, after investigating the matter for many months, has recommended for general adoption certain standards. According to these recommendations there are five permissible standard lengths between the limits of 1½ and 2½ in. inclusive (to be reduced where possible to three). There are five permissible standard widths between the limits of 1 and 1½ in. inclusive (to be reduced where possible to three), and there are 10 permissible standard thicknesses between the limits of 5/16 and 1 in. inclusive (to be reduced where possible to eight). Thus, even within comparatively narrow limits, there are 250 permissible standard sizes (to be reduced where possible to 72). This would appear to suggest that designers in America are of the opinion that very considerable latitude must be left to them in the selection of brush dimensions.

"The dimensions of the actual block, however, are only the beginning of the problem. There is the question of fittings to be considered. If brushes are really to be standardized as regards their mechanical design, a certain degree of uniformity in the design of holders becomes necessary, so as to permit uniformity in the length and position of flexible and also in the type and size of terminal. When it comes to a question of quality this would appear to defy all efforts at standardization, except possibly on exceedingly broad lines. Even standardization of machine design would not completely eliminate the difficulties here, since the differences in brush properties are so subtle and yet so pronounced in their influence on the behavior of a machine that it seems fundamentally impossible to harness them in a specification.

"A certain measure of standardization is possible within prescribed limits. Any recommendations that could be applicable to all types of machines, however, must necessarily be on such very broad lines that they could scarcely be described as standardization. It is therefore wise to proceed by stages, including at first only the mechanical design of the brush and applicable only to machines intended for a certain class of work, such as motors and generators (excluding turbo dynamos) for shipboard use. This is the sphere in which the benefits of standardization would naturally make themselves most felt, and by proceeding cautiously in this way it may in time prove practicable to introduce recommendations of a more comprehensive character."

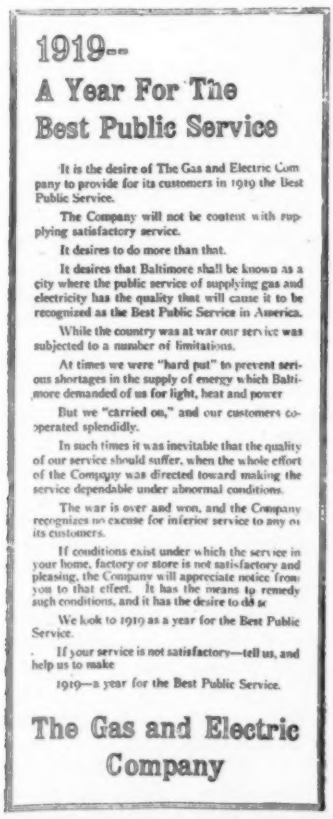
Commercial

Electrical Utilities Emphasize the Importance of Service—Helping Appliance Sales—Utility Stock Among Consumers

MAKING 1919 A YEAR OF THE BEST PUBLIC SERVICE.

Consolidated Gas, Electric Light & Power Co. Starts Movement to Improve Service During Coming Year.

The Consolidated Gas, Electric Light & Power Co., of Baltimore, Md., will make a sincere effort during the coming year to improve, if possible, the quality of its service to its customers. This company, one of biggest in the country, has already established a very good reputation in this respect which it has maintained very creditably even during the war period. Realizing that the continuation and improvement of such service can only be accomplished by constant effort and watchfulness on the part of every employe and through the proper knowledge and co-operation of its customers, a campaign has been started to aid in bringing out these essential features.



1919—
A Year For The
Best Public Service

It is the desire of The Gas and Electric Company to provide for its customers in 1919 the Best Public Service.

The Company will not be content with supplying satisfactory service.

It desires to do more than that.

It desires that Baltimore shall be known as a city where the public service of supplying gas and electricity has the quality that will cause it to be recognized as the Best Public Service in America.

While the country was at war our service was subjected to a number of limitations.

At times we were "hard put" to prevent serious shortages in the supply of energy which Baltimore demanded of us for light, heat and power

But we "carried on," and our customers cooperated splendidly.

In such times it was inevitable that the quality of our service should suffer, when the whole effort of the Company was directed toward making the service dependable under abnormal conditions.

The war is over and won, and the Company recognizes no excuse for inferior service to any of its customers.

If conditions exist under which the service in your home, factory or store is not satisfactory and pleasing, the Company will appreciate notice from you to that effect. It has the means to remedy such conditions, and it has the desire to do so

We look to 1919 as a year for the Best Public Service.

If your service is not satisfactory—tell us, and help us to make

1919—a year for the Best Public Service.

The Gas and Electric
Company

Copy of Advertisement of Consolidated Gas, Electric Light & Power Co. Which Appeared in Baltimore Papers.

The January issue of the *Baltimore Gas and Electric News*, the house organ of the company, contains a very interesting article which explains the value and requirements of good public service and the methods to make it better. Good public service is the result of the application of honest and intelligent methods to public service. The greater the degree of intelligence, and the greater the energy and consistency of its application, the greater will be the quality of the service rendered.

It is explained that the company is still operated for the same purpose for which it was formed, namely, public service. As the company has always received good treatment at the hands of the public, it considers the proper performance of this duty merely as the fulfillment of its obligation to the public.

The company has a General Service Department among whose duties are the reception and acknowledgment of complaints from customers and the institution of the proper steps to rectify them. However, good service, it is pointed out, should not be limited to this department but applies to every member of every department. Furthermore, the activity should not be limited to giving good service but must be extended to prevent bad service. This preventive work must start in the generating plant and with vigilance and vigor be carried through all of the other departments that have to do with the distribution of gas and electricity, or with the installation and maintenance of appliances, or motors, which are eventually used by the customers in the application of the energy which is created and distributed.

In conclusion the article brings out very forcibly the reasons for giving good service. Primarily, there is no excuse for bad service and every reason for good service. It is easier to give good service, it is pleasanter to give good service and it is more profitable to give good service, but, most important of all, it is a duty to give good service.

Following the same idea of bettering its service the company started an advertising campaign in the leading papers of Baltimore to educate its present and prospective customers in the methods of securing good service and to gain their co-operation in the company's sincere effort to give the best possible service. One of these advertisements is reproduced herewith. This idea, which has been adopted with great success by a number of central-station companies and which is rapidly spreading all over the country is to be greatly recommended. The frank publication of the policies, aims and methods of public service companies will do much to gain the confidence and co-operation of the public and these are now recognized as the greatest asset any company can have.

SERVICE IS BASIS OF PUBLIC UTILITY OPERATION.

Keynote of Address by President Porter of Kansas City Light & Power Co.

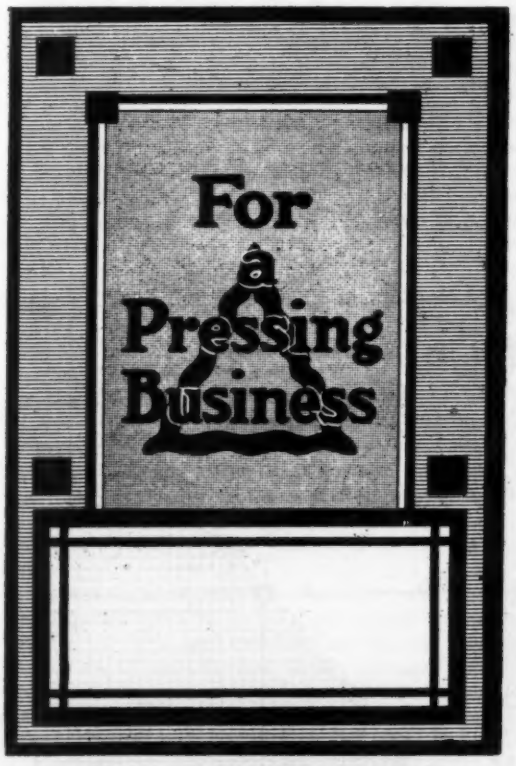
The belief that if Kansas City, Mo., is to grow industrially she must co-operate with those who bring and make business, caused the Chamber of Commerce

of that city to request J. F. Porter, president of the Kansas City Light & Power Co., to address that body recently and give the public a full conception of the prospective facilities of the company. He told in detail of the new power plant now under construction and of the amount of power which will be available and will be produced at a moderate cost. "The basis of utility operation," he said, "is service. The better the service the lower the rate. Be sure when you criticise that the thing opposed is not some necessary step for economical and efficient service. The less friction there is in the working of a company, the easier and cheaper it is to give good and satisfactory service. Public officials are realizing this and are assisting rather than hampering corporations in improvements required for better operations."

CATCHY BOOKLETS AND PHRASES STIMULATE APPLIANCE SALES.

Chicago Central-Station Company Finds Public Favor Is Readily Developed in Appliances.

The popularity of things electrical is based on merit and ordinarily needs little intensive boosting to stimulate sales. During a prolonged period of high prices and high living cost in general, it may be well to accelerate the sale and use of electrical appliances and thus increase the turnover of stocks purchased at above normal cost. This idea has been found of advantage by the Commonwealth Edison Co., the large and aggressive central-station company of Chicago. Its sales of electrical appliances during the recent holidays and even during this month of January have exceeded all records. One of the reasons for this is the use of catchy phrases in newspaper advertising, on booklets, show-window display cards, etc. The cover of a booklet on electric ironing is reproduced herewith. It is keeping before the public such ideas as "If it isn't electrical, it isn't modern," "Electricity takes the work out of housework," "Let the Electric Washer banish Blue Monday," etc., that keep the public desire for electrical appliances keyed up to the buying point. Electrical dealers can get inspiration from the experiences of aggressive organizations like the one in question, which is doing its utmost to make Chicago the leading electrical city.



Catchy Cover of an Electric Iron Booklet.

CITIES SERVICE STOCKHOLDERS NUMBER OVER FIFTEEN THOUSAND.

Some interesting figures relative to Cities Service Co. stockholders have been prepared by T. A. Wallace, head of the transfer department of Henry L. Doherty & Co. They show that on Nov. 15 last the number of stockholders was 15,031, a gain of nearly 3000 over the corresponding date of 1917. The figures on Nov. 15 for the last four years were as follows: 1915, 6287; 1916, 9505; 1917, 12,239; 1918, 15,031.

The Cities Service Co. owns most of the smaller companies operated by Henry L. Doherty & Co. These smaller companies are scattered over the entire country and include in addition to numerous electric, gas, water and electric traction service companies, a number of oil concerns. The rapid growth in the number of stockholders in this company is further evidence of the disposition of many of the larger public service corporations to dispose of their stock as far as possible among their customers.

WATER PUMPED ELECTRICALLY SAVES MONEY FOR PUEBLO.

At the South Side water works at Pueblo, Colo., an electrically driven, direct-connected pump, of a capacity of 3,000,000 gallons daily was installed during the year 1918. The city is now preparing to install a second unit with 6,000,000 gallons daily capacity, and it is the intention of the trustees to electrify the entire pumping system during 1919. All of the energy is supplied by the Arkansas Valley Railway, Light & Power Co. The trustees estimate an annual saving of $10,000 when the plant is completely equipped for electrical operation.

HIGHER RATES IN DENVER UPHELD.

The Supreme Court of Colorado has declined by a vote of 5 to 2 to grant the application of the city attorney of Denver, James A. Marsh, for a writ of prohibition to prevent the Denver Gas & Electric Light Co. from collecting the higher rates recently authorized by the Colorado State Public Utilities Commission.

This decision is not a ruling upon the question of the Commission's jurisdiction over public utilities in home-rule cities. It does, however, allow the Denver Gas & Electric Light Co. to maintain the present rates pending final decision.

RECORD INCREASE OF ELECTRICAL CONNECTIONS.

During the month of December, 1918, 86 new electric consumers were added to the lines of the Sandusky Gas & Electric Co., Sandusky, Ohio. This is the largest number of connections obtained in any one month in the history of the company. At the rate old houses are being wired, it will only be a matter of a few years when practically every residence in the community will be using electric service.

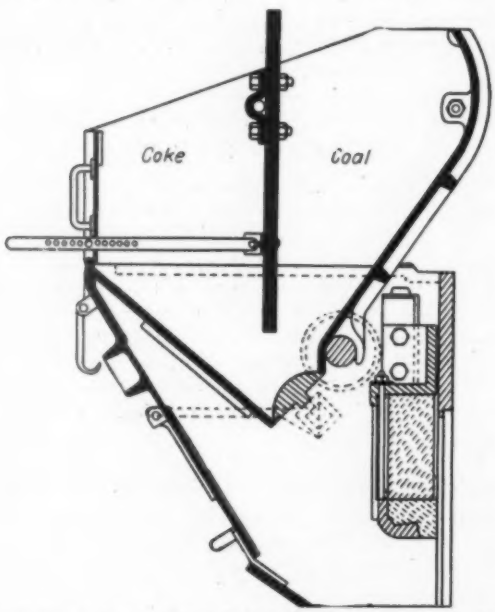
Operating

Coke as Fuel—Cost of Leaky Valves—Portable Outfit—Safety Rules — Uses of Reactance — Liquid Rheostats

USING COKE IN POWER PLANTS.

Results of Using Coke and Modified Equipment for It.

There has been far too much prejudice in the past in connection with the burning of coke fuel. On a hand-fired boiler a distinct thermal advantage is obtained by using coke, since the hydrocarbon loss which immediately follows the firing of bituminous coal is absent. With many types of mechanically-fired boilers this advantage does not occur, but in both cases the use of coke fuel is limited by the quantity which can be consumed per hour on a given grate area and with a given draught. On many boilers where the draught is insufficient, steam jets have been applied with fairly satisfactory results, but in such cases it is very necessary to ascertain accurately the amount of steam used in producing this extra draught.



Partition Plate for Controlling Coke and Coal Fed to Stoker.

Mechanical stokers have been designed or modified for burning coke with good results. Many plants are using coke mixed with coal in mixtures varying from 5 to 50%, using for the purpose chain grates and underfeed stokers. The accompanying results were those obtained with coke as fuel, a two-thirds mixture:

	Coal.	Coke and Coal.
Draft, at uptake	⅝-in.	⅝-in. to ¾-in.
Fuel burnt per sq. ft. of grate area per hour (lb.)	26	26 to 30
CO_2 (per cent)	8	10 to 12.5
Excess air (per cent)	159	100 to 65
Evaporation from and at 212° F. per lb. of fuel as fired (lb.)	7	7.8
Evaporation per sq. ft. of grate area per hour (lb.)	182	202 to 234

The accompanying illustration shows a simple arrangement of a partition installed in the hopper of a chain grate stoker to permit feeding coke and coal to the grate in varying quantities. The hopper above the boiler is also partitioned, one section containing coal, the other coke. Another function of this baffle or plate is to feed the fuel on to the stoker in layers.

COST OF LEAKY BLOW-OFF VALVES.

Chart Showing Annual Cost of Fuel and Water Due to Leaky Valves.

In aiming to bring about power plant economy, of which so much has been said until quite recently, the big and spectacular things are more likely to be attended to while the smaller, less conspicuous things are passed by without attention. However, the small things, each small individually, assume large proportions when the summation of their losses are capitalized or taken over a long period, as for one year. Moreover, so many of the small wastes in a power plant—which are invisible frequently—exist for many hours per day, often all day, twenty-four hours a day; and these small losses can usually be reduced or prevented altogether with little trouble or expense, and when once remedied are remedied for a long time.

One of the invisible nominally small losses is that due to leaky blow-off valves. This loss is often ignored, is supposed to be small, and is easily remedied.

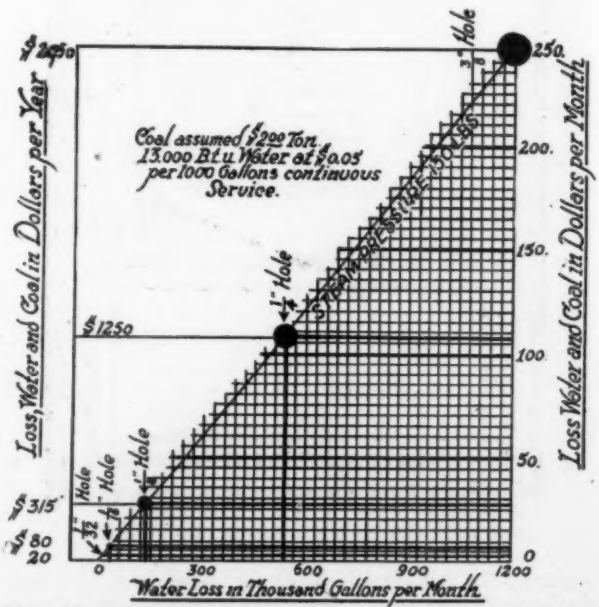


Chart Showing Annual Cost in Dollars Due Loss of Water and Heat Through Leaky Blow-off Valves.

The accompanying chart, gotten up by Yarnall-Waring Co., gives the cost of leaky blow-off valves. This

cost is made up of two items, namely the cost of water lost through leakage and the cost of heating this water. The steam pressure is taken as 150 lb. per sq. in. The loss is stated in the following table, for various size of leak holes:

Size of hole in valve	Loss in dollars per month for water and coal
1/32 in.	$ 2.50
1/16 in.	8.00
1/8 in.	26.00
1/4 in.	107.00
3/8 in.	250.00

When installing boiler room instruments, modern efficient apparatus, cost accounting systems, etc., do not forget to repair any leaky valves or, wherever possible, institute such valves as will not easily develop leaks under ordinary operating conditions for such leaks often prove very expensive.

ELECTROSTATIC EFFECT DETERMINES TRANSFORMER CONNECTIONS.

Ionized Air and Bombardment of Conductors by Dust Indicates Line Conductors.

By H. M. Barton.

The practical worker in criticising the college-trained man so often makes the statement that he is "not practical," that he fails to apply the schooling he has obtained to practical workable things. Unfortunately this is often very true, until the college man has had time to realize that at school he is taught laws and their applications and that it is in applying them to the work on hand that he is able to prove whether his schooling has been of any real practical service to him or not.

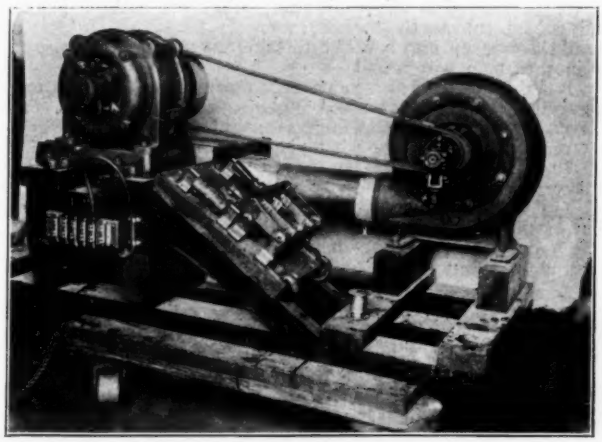
A recent instance is interesting as showing the way in which a law of science may be connected up to a practical application. In a large substation containing a number of 66,000-volt transformers the writer noticed that one conductor leading from one terminal of each transformer on the 66,000-volt side was a dark color, as if covered with dust. The conductors from the other terminal were clean, giving the appearance of being comparatively new metal. Aluminum was used. The transformers were connected in banks, each bank being connected in star on the high-voltage side and delta on the low-voltage side. It was the conductors connecting the transformer terminal to the neutral of the "Y" or star that had the comparatively clean, whereas the conductors that were connected to the phase wires had a dirty, dusty appearance.

The explanation is simple. An electrostatic field is set up around a conductor above earth potential, the strength of this field tending to become greater the greater the potential difference between it and earth. Stresses are set up in these fields, causing an agitation of dust particles, ionization or electrification. The 66,000-volt conductors, raised 38,000 volts above ground, set up an electrostatic field that resulted in agitation of the dust particles in the station. These in their agitation bombarded the clean aluminum conductor, covering same with dirt and dust. The conductors on the earth side of the transformer terminals were not so dirtied because the potential of the conductor was that of earth hence no electrostatic field existed and no ionization of the ambient air, therefore, occurred.

PORTABLE HOT-AIR MACHINE FOR DRYING OUT PURPOSES.

Equipment Used by Georgia Railway and Power Company for Drying Out Apparatus, Manholes, etc.

A portable drying-out outfit built and used by the Georgia Railway and Power Co. is shown in the accompanying illustration. This outfit is capable of delivering 1000 cu. ft. of free air per minute at a maximum temperature of 140° C, hence is intended for drying out purposes, such as large transformers,



Portable Drying-Out Unit Used by Georgia Railway and Power Co. for Drying Apparatus and Manholes.

subway holes and manholes, conduit and duct lines, large generators or motors on the system of the Georgia Railway and Power Co. or those belonging to their customers and others. Another purpose for which this unit is used is to test lubricating oils that do not require chemical analysis.

The portable hot-air or drying-out outfit is seen to be completely assembled ready for immediate use, because it often is required on short notice by the men installing station apparatus, underground lines and making customers' repairs, etc. The motor and electric heater are controlled by one switch, the motor starting at the same time the heater evolves heat, therefore, and vice versa. In this way the work of starting and stopping the unit is simplified, and the possibility of burning out the heating element is obviated.

PERSONAL SAFETY AROUND THE BOILER ROOM.

In a recent issue of the *Au Sable News* appeared some good suggestions for the personal safety of the boiler room force. These suggestions were as follows:

1. When working on underfeed stokers see that speed shaft clutches, dump plate levers and apron mechanism are marked with red "Danger" tags. Men working on extension grates, dump plates, or clinker grinders are likely to be seriously injured if the stokers are operated with the dump plates raised into position or aprons closed.
2. When working in the path of the coal weigher, do not fail to notify the coal passer. Neglect to do this has resulted in fingers being badly crushed between weigher and track.
3. Never work in same end of car with coal crane bucket. A swiftly moving bucket is not readily controlled, and a man stands chances of being seriously, if not fatally, injured.
4. When working in combustion chamber, cleaning out superheated or blowing ashes, wear close fitting goggles

to protect the eyes from the fine dust, and respirators, if necessary, to protect the lungs.

5. Ash men should guard against being burned on removing clinkers from ash hoppers; also, in dumping contents of ash car in water pit, to avoid being scalded.

6. Only men properly instructed should dump coal cars. Serious accidents have occurred due to men being caught under the car by pocket suddenly opening; or being hit by suddenly released coal, due to standing in unsafe positions.

7. All extension cords must be inspected before using and under no circumstances should metal sockets be used. Cords in wet drums should rest on dry boards. Too much caution cannot be exercised in inspecting extension cords since in the boiler room conditions are such in most instances, for serious if not fatal accidents occurring if defective cords are used.

8. Be sure that all combustion ashes are wetted down and cooled sufficiently before removing same. In no case should a man go into a boiler to take out ashes unless there is another man within call.

9. When placing or removing washers on lower ram connecting rod of underfeed stokers, great care must be exercised not to get the fingers caught and crushed. Do not reach in blindly—see what you are doing.

10. Great care must be used if working in underfeed stoker coal hoppers—otherwise a crushed foot will result.

11. All boiler room men must be familiar with the operation of the shifter lever of the underfeed stoker—so that in case a man is caught the driving clutch can be thrown out without dangerous delay.

CONTROLLING LARGE AMOUNTS OF POWER BY REACTANCE.

Schedule Showing Utilization and Location of Reactance and Its Limitations.

The installation of reactances for the protection of apparatus from high-frequency or so-called lightning effects is very old. Of later application is that of protecting apparatus from heavy current rushes or limiting the flow of energy from one machine to another or one part of the system to another by the insertion of reactance. The more common instances of this are the reactances installed in generator leads, in sections of bus-bars to limit interchange of energy, and in feeders.

Reactances, whether having ferric or air cores, have a number of disadvantages—and limitations. They occupy space, they cost money, increase voltage drop, cause phase displacements, lower power-factor, and absorb energy. The accompanying schedule or table, from a paper read before the Institution of Electrical Engineers on the "Control of Large Amounts of Power," may be of interest, for it outlines various locations in the electric generating and transmission system where the reactance may be installed for the control of energy. This schedule also indicates the limitations and disadvantages of the reactance so installed.

CONSIDERATIONS INVOLVING LIQUID RHEOSTATS.

Liquid starters for the control of three-phase motors in steel mills, coal docks and similar places have been used extensively. Although cheap, it occupies considerable space, needs little attention and has low cost for upkeep. It gives a form of control that is often very convenient, as for motor-generator-flywheel sets used for hoisting where the "slip" of the induction motor has to be varied to permit the momentum of the flywheel to come into play.

However, the liquid rheostat sometimes gives trouble due to leakage of the electrolyte or change in its specific gravity. The type of starter having three separate tanks often gives trouble, owing to the electrolyte in the separate tanks differing in specified gravity. This has been due in some instances to a tank leaking and then being filled up with water, instead of the whole quantity of electrolyte being taken out or run off and made up to one strength and then refilled. It is generally thought that much better results can be obtained by using a single tank instead of three tanks, one for electrode, as the common electrolyte does not allow unbalanced rotor currents, with the result that better starting effort would be obtained and a greater output to be obtained on the one-minute rating.

SCHEDULE.

CONTROL OF LARGE AMOUNTS OF POWER BY USE OF REACTANCE.

Requirements.

To limit the area affected by a disturbance at any point.

To limit the power concentrated at any point on a fault occurring.

Characteristic.

Wherever employed, reactance limits disturbance in all parts of the system beyond it, and tends to isolate disturbance from all parts nearer to the source of supply.

Means.

A. *Utilisation of Inherent Reactance.*—Advantages: Saves cost of special reactances and does not add to resistance and consequent losses.
Limitations: Where the load is at all concentrated, cannot be carried far enough for economical reasons.

B. *Utilisation Artificial Reactance.*—Advantages: Can be located where most effective.
Limitations: Must not interfere with regulation.

Method of Employing Reactance in General.

I. *Reactance in series.*—Advantages: Easy to apply.
Limitations: Carries total load fed to part protected.

II. *Reactance in Parallel.*—Advantages: Carries only portion of load transferred. Wastes less energy. Interferes less with voltage regulation.
(Sectionalizing or interconnecting) Limitations: Requires sectionalizing of distributing system. Is not sufficient alone if good regulation maintained.

Methods of Employing Reactance in Series.

(*a*) *In Generator.*—Advantages: Cheaper. Does not hinder voltage control under normal conditions.
Limitations: Consideration of design of machine. Must not swamp isolating effect of bus-bar and feeder reactances.

(*b*) *Added to Generator.*—Advantages: Limits current which can flow into faulty machine.
Limitations: Increased cost and space required. Must not swamp isolating effect of bus-bar and feeder reactances.

(*c*) *In Feeder.*—Advantages: Gives best protection to rest of system.
Limitations: Interferes most with voltage on part protected.

(*d*) *In Group of Feeders.*—Advantages: Minimum number of reactances required. Protects feeder switchgear.
Limitations: Involves several feeders where fault in one

Contracting-Construction

Second Croft Article on Pulling in Wires—Charging Circuit Release—Court Holds Enforcement of Code Illegal

ATTACHING CONDUCTORS TO FISHING WIRES AND PULLING-IN LINES.

Method of Coupling Small and Medium-Sized Wires to Fishing Tape and Rope Pulling-in Lines.

BY TERRELL CROFT.

[*This is the second of three articles that discuss the different methods of connecting the fishing or pulling-in means to the wires to be pulled into a conduit system. These articles are practically a continuation of the series of seven articles on fishing conduit by this well known author that were published in the* ELECTRICAL REVIEW *of Aug. 24 to Oct. 5, 1918. The increasing importance of conduit work and the dearth of information available on this subject should make these articles of interest to contractors and electricians.*]

In Disposing the Outer Braid Covering on Twin Wire so That the Wire Will Pull in Readily the procedure diagrammed in Figs. 5 and 6 may be followed. It sometimes occurs, unless proper precautions are taken, that the outer braid will, on the conductors being pulled in, slide back and form an obstructing bunch around the conductors as shown in Fig. 4. Such difficulties may be avoided if the outer braid is first ripped longitudinally with a knife (Fig. 5) and then folded back as shown in Fig. 6. Where this is done it may be unnecessary to serve a tape covering over the attachment.

Fig. 4.—Showing How Outer Braid May "Bunch Up" on the Outside of Twin Wire.

Fig. 5.—Outer Braid of Twin Wire Stripped Off.

A Method of Attaching a Rope Pulling-in Line to a Steel Fishing Wire is delineated in Fig. 7. If the conduit has been fished with a steel-ribbon fishing wire and conductors larger than No. 12 are to be hauled in, it is best to use a drawing-in line and to pull it in with the fishing wire, rather than to attempt to pull in the conductors directly with the fishing wire, for the reasons hereinbefore outlined. The fishing ribbon *R* (Fig. 7) is made fast to the pulling-in line *L* by inserting it through a slit which has been cut in the rope at *H*. A serving *C* of small diameter copper wire is made around the free ends of the fishing wire. Then the entire attachment is covered with friction tape as shown in Fig. 1 (here produced for convenience) so that it forms a conical wedge. Frequently rope pulling-in lines have loops braided in each of their ends. Into one of these loops the fish wire used for drawing in the pulling-in line, or the conductors which are to be pulled into the conduit with the pulling-in line, can be attached. Sash cord makes good pulling-in lines.

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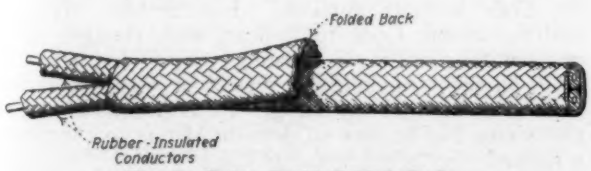


Fig. 6.—Outer Braid Folded Back.

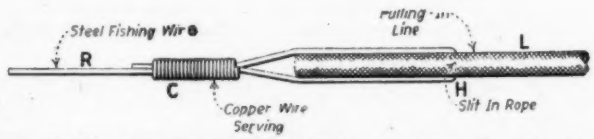


Fig. 7.—Showing How Fishing Ribbon or Wire May Be Attached to Rope Pulling-in Line.

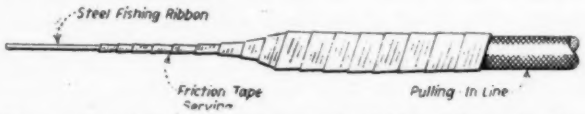


Fig. 1.—Taped Over Attachment of Fishing Ribbon to Rope Pulling-in Line So as to Present Gradual Taper.

In Attaching Two Medium-Sized Conductors to a Rope Pulling-in Line Which Has no Loop in Its End the method of Fig. 8 can be used. The bared end of cut in the rope and is made up about the end of the rope as suggested. Then the bared end of the other conductor C_2 is made up around C_1 as shown. To complete, serve with friction tape. All of the com-

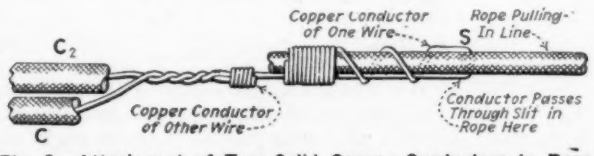


Fig. 8.—Attachment of Two Solid Copper Conductors to Rope Pulling-in Line.

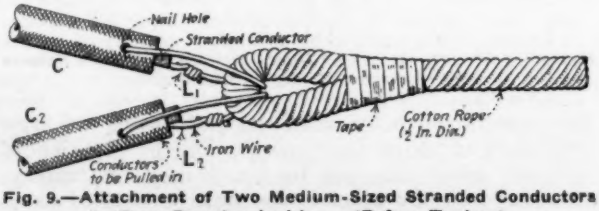


Fig. 9.—Attachment of Two Medium-Sized Stranded Conductors to Rope Drawing-in Line. (Before Taping.)

ponents should be so disposed that the attachment will taper from the rope toward the conductors. This may be effected by filling the low places in with friction tape similarly to Fig. 1.

In Attaching Medium-Sized Stranded Conductors to the Loop in the End of a Rope Pulling-in Line, short links L_1 and L_2 (Fig. 9) can be used for fastening the conductors C_1 and C_2. These iron-wire links are threaded through holes, punched through C_1 and

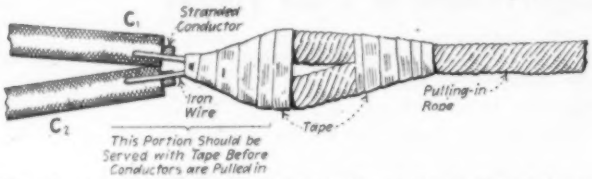


Fig. 10.—Same Attachment Shown in Fig. 9 Partly Taped Over.

C_2 with a nail. Fig. 10 shows the attachment partially taped. The completed attachment should be entirely taped over, about as suggested in Fig. 1.

(To be continued.)

SUGGESTION FOR THREADING CONDUIT.

By J. A. Weaver.

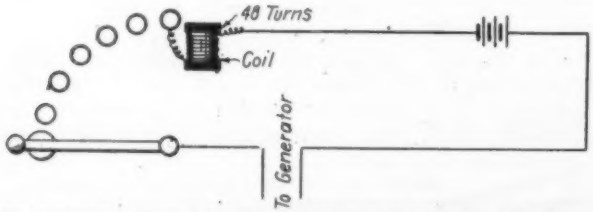
In threading conduit it often happens that when starting a die it will not take hold due to an uneven end or some other such reason but will strip the first few threads and chew up the end of conduit so that no matter how much pressure is used on the die stock, the die will not start. When this happens on a length of conduit that has already been cut to exact length and which therefore will not permit the stripped portion to be cut off, the trouble can be quickly overcome by the following method:

If the end of conduit is upset by hammering so that a burr is raised on its surface, this burr will enable the die to take hold easily and complete the thread. Of course, the burr on the inside of conduit should be removed with a burring reamer, file or the nose of a pliers immediately, for if it is left on the conduit it will be very apt to cut into the insulation of the wire when it is pulled in.

PRACTICAL RELEASE FOR BATTERY-CHARGING CIRCUIT.

By Harry Dean.

In many plants using electric tractors the question of charging the batteries of these vehicles is a prominent one. Usually this charging is done at night as



Method of Connecting Unused Direct-Current Starter as Release in Battery-Charging Circuit.

the tractors are in constant demand during the day. This work of course is commonly done by experienced men but when only one tractor is used the battery-charging cost, if a special man must be detailed to do this work, is excessive. For this reason this work is often left to the watchman or guard to perform. Although the results obtained are often far from satisfactory, one difficulty at least may be cheaply eliminated by using the following method which was brought out in a small plant using one tractor.

In this plant it was found necessary to charge the battery at night using inexperienced help. The greatest difficulty encountered was the fact that these employes when shutting-down the generator, after the battery was charged, neglected to disconnect the battery circuit from the generator. In addition to running the battery down this method also reversed the polarity of the generator. To combat this difficulty the face plate of an old d.-c. starter was connected in series in the battery line as shown in the illustration. The magnet was re-wound with 48 turns of No. 6 magnet wire and also put in series with the line. Now, whenever the motor-generator is shut down the handle will automatically return to the off position. It was found that 20 amp. were necessary to hold the arm in the charging position.

KANSAS COURT FAILS TO LEGALIZE NATIONAL ELECTRICAL CODE.

Decision in Appealed Case Finds Legislature Cannot Make Code a Part of the Law.

A Kansas court has decided that the law of Kansas compelling owners to wire their houses according to the National Electrical Code and making it a penal offense if they do not, is invalid. The case came up when L. M. Crawford of the Grand Theater, Topeka, Kans., was charged with such a misdemeanor. The lower court decided in his favor and Justice Dawson confirmed that decision in an appeal case. He stated that the Legislature had no authority to delegate power to any person or association to make obligatory rules with regard to the care and management of property, nor to make it a misdemeanor to neglect their instructions. In rendering his decision Justice Dawson was caustic in his remarks concerning the Legislature and held that it would keep a man busy following the changes in the Code, so that after wiring his house according to specifications one day he might the next be called upon to do it over again.

This case seems to be a novel one and apparently arises from the law making compliance with the Code mandatory. In cities and districts where the City Council or a municipal department, board or commission is authorized to make rules for the installation of electrical equipment and circuits, no trouble is experienced in making these rules conform with the National Electrical Code or bodily include the latter, the rules being revised every few years to correspond with revised editions of the Code necessitated by the advance of scientific knowledge of electricity and progress of the electrical arts. In all probability the case was not fully presented to the courts in question, which would not have indulged in caustic remarks if informed of the high regard in which the National Electrical Code is held by the public as well as by all electrical and insurance interests wherever the Code is fully applied. Furthermore, there is nothing in the Code to indicate that changes in it necessitate changes in existing wiring and even in cities having a reinspection system to keep the wiring in good condition such changes are not required unless the wiring has become so deteriorated as to constitute a hazard.

QUESTIONS AND ANSWERS

All readers are invited to submit questions and answers to this department. Anonymous communications will not be considered. Questions should relate to electrical matters of any kind. Answers contributed by readers should be submitted preferably within eight days of the date of publication of the question and should be limited, if possible, to 300 words. Payment will be made for all answers published.

Questions.

No. 450.—MEANING OF "NEW INSTALLATIONS."—A discussion has arisen as to the meaning of the words "new installation" in the ordinance defining the authority of the inspector of wires of the city of Fall River, Mass. Section 2 (b) of this ordinance says:

"New installations shall not be connected with the source of the electrical supply until the inspector of wires passes its system of wiring as safe."

Does this refer to any wiring which may be done when a meter is already installed (such as installing one light in addition to 10 lights which were installed at some previous time) or an installation which has no meter in place and where it will be necessary to install a meter to deliver current to the system of wiring? What is the ruling on this in other cities?—M. T. A., Fall River, Mass.

No. 451.—GROUNDING OF DIRECT-CURRENT CIRCUITS.—Why is the number of circuit grounds on direct-current systems restricted in the new rules 15A*b* and 15A*b* of the National Electrical Code? The former requires a ground on the neutral of three-wire systems at one or more supply stations, but not at individual services or within buildings served; the second rule provides for a ground on two-wire systems at one station only. It seems to me that the more grounds there are the more perfect is the protection that is afforded.—H. J. N., Milwaukee, Wis.

No. 452.—REQUIREMENT OF ENCLOSED KNIFE SWITCHES.—In how many cities and in what large cities is there a municipal or other regulation requiring the use of enclosed knife switches for motor or other heavy circuits or prohibiting use of open knife switches for such purposes?—T. B. A., New York, N. Y.

Answers.

No. 446.—LAMP-LIFE RECORD SYSTEM.—Where it is impossible to mount lamps out of reach or to employ locking sockets and etched bulbs to prevent or deter theft, what means are taken to secure record of breakage and length of time lamps remain in sockets, or electrical life? Is it practical to use corresponding socket and lamp numbers or labels?—M. K., New York City.

Answer A.—In but one case which I recall was a labeling system used in order to ascertain the length of electrical life of incandescent lamps in a large plant. In this incident, each lamp intended for use in certain buildings of the plant was labeled by means of a small sticker put on close to the stub. When a lamp required replacing, the date was marked upon this label and then covered with a thin coat of shellac for protection. The electrician in charge of the building made record in a record book regarding both the new and the old lamp. The length of life of various lamps could then be had at any time through reference to this book. This particular case was not, however, to secure the record of the loss of lamps through theft, but rather to obtain, through a series of exhaustive tests, the proper method of suspending lamps to withstand the excessive vibration of heavy machinery. In the case in hand, an intricate problem is presented through the inability to use any means of protection from breakage or theft. The above-mentioned system would be of service in this case—but the presence of a label would hardly prevent the removal of the lamp by unauthorized persons. If the use of locking lamp guards is not prohibited, these might be recommended for thorough protection of the lamp.—W. F. P., Atlantic, Mass.

Answer B.—In keeping a record of lamp life we have found it nearly impossible to keep a record of each individual lamp and so we now use the following method to ascertain average lamp life. We attach stickers of thin paper, using shellac, to about 15 lamps, put a number on the paper and cover with shellac. We then install the lamps in a place where they are not likely to be disturbed and where we know approximately the length of hours burned per day. Then by keeping a record of the date given out and the date returned we know approximately the hours of lamp life. As a further check we sometimes take the number of lamps used in a room or in the whole plant and estimate the number of hours that each lamp or group of lamps is used for a certain period. Add up the hours to get total lamp-hours and divide by the average number of hours burned by test lamps. This will give about the number of lamps you should be using and serves as a rough check on abnormal renewals caused by high voltage, theft, or careless breakage.—A. S. N., Plymouth, Mass.

No. 447.—PULLING IN HEAVY CABLE.—In pulling in some 500,000-cir. mil cables into conduit we have not been able to make a good fastening that will hold between the pulling-in rope and the cable. Will some electrician who has had considerable experience in this line of work advise through ELECTRICAL REVIEW how such a connection can be made satisfactorily?—R. B., Kankakee, Ill.

[Answers *A*, *B* and *C* published in ELECTRICAL REVIEW of Dec. 28, 1918. Also see articles by Terrell Croft on "Attaching Conductors to Fishing Wires and Pulling-in Lines", in ELECTRICAL REVIEW, Jan. 11, 1919, and in this issue.—Ed.]

Answer D.—The sketch herewith shows one of the methods I have frequently used and the one I find to be best. The holes are made in the rope for the

No. 447.—A Method for Attaching Pulling-in Line to Cable.

wire by driving a nail through it. Two loops will answer the purpose all right. The cable wires are then put through and twisted around as shown and then soldered. The connection is then taped and before pulling in if a little soapstone powder is rubbed on the tape it will help greatly. If there are any bends in the conduit it will be advisable to let the cable run through soapstone powder held in the hand. Make it a practice not to jerk on the pulling rope if it should get stuck; a steady pull will always be found the best. Try to have connection not any larger than the outside diameter of the cable if possible.—A. G., Ansonia, Conn.

No. 448.—WHAT IS AN ACCESSIBLE ATTIC?—What is the real meaning of the term "accessible attic," which occurs in National Electrical Code Rule 28*g*? This rule states that junction boxes are considered accessible "when installed in an attic that has sufficient headroom but which is reached only by a portable ladder and permanent hatch." What would be deemed "sufficient headroom"? Would a space having a vertical clearance of 2½ or 3 ft. in a reinforced concrete building, space being entered by manholes located in the floor, be considered an accessible attic, and could junction and pull boxes not opening on the outside be installed in such an attic without violating the intent of the Code rule?—D. A. T., Cincinnati, Ohio.

Answer A.—An "accessible attic" is that space, directly below the roof of a building, to which access is had by means of a permanent hatch, window or small door. Interpretation of "sufficient headroom" may vary with the local inspection departments, but I have personally installed pull and junction boxes in such attics which have had but 18 or 20 in. of headroom. This height in this particular case was considered as sufficient. The space in question can hardly be considered as an attic—since it is entered from the top—but there can be no objection to installing boxes in such a place as long as it has a vertical height of from 2½ to 3 ft. It will probably be necessary to keep the manholes clear of material at all times, as the storing of such in their close vicinity would possibly interfere with the "accessibility" of the place.—W. F. P., Atlantic, Mass.

Answer B.—The first sentence in this rule says that "Junction boxes must always be installed in such a manner as to be accessible . . ." This is the keynote of the rule. Such boxes must be accessible not only for making junctions or taps, but for inspection and reinspection. An improperly made tap in an inaccessible box is likely to cause a hazard. If inspection is rendered difficult by comparative inaccessibility of the box, it is possible that it may be negligently overlooked. The local inspector will be the final judge of what amount of headroom he will require for getting at the box without great discomfort. I should say that not less than 2½ or 3 ft. would be needed to reach the box on hands and knees. Less headroom than that would require the inspector to crawl into the attic flat on his belly. This is not only uncomfortable for the inspector but also for the wireman, and the latter would have difficulty in making a good job of splicing in the box under such circumstances. Less than 2½ ft. would not be considered "accessible" in my opinion.—C. T. J., Chicago, Ill.

Answer C.—The real meaning of accessible attic depends, of course, on the local inspector. In any case it should mean that the junction boxes would be considered as in an accessible attic if the attic were high and large enough to allow conductors to be properly pulled in without danger. For small cable 2½ to 3 ft. vertical clearance would prove sufficient, but not so if the cables were large. However, the dividing line is not sharp and the local inspection bureau should be consulted in all cases if there is doubt.—H. E. W., Chicago, Ill.

No. 449.—WIRE FOR FISHING.—Is flat steel wire much better for fishing conduits than round wire? We do not do very much conduit work here and have been using round galvanized steel wire and have gotten along all right. If the flat or ribbon wire is better, why is it better and what size should I buy for ½-in. conduit?—T. A. N., Cheyenne, Wyo.

Flat steel fish tapes are of greater advantage than round steel wire, due to the fact that they are highly tempered and can be shoved a greater distance without bending or kinking. In the case of a run of conduit where there are a number of elbows, and the run is fairly long, a steel tape can be inserted from each end, and with hooks bent on the ends of same, they can be made to engage each other by giving the tape a turn or two from one end. Another advantage is that in the absence of a helper, when fishing from outlet to outlet on ceiling work, the tape can be given a circular bend on the end and so inserted in the conduit, that when the tape is pushed through it will be found that instead of the tape striking the edge of the outlet and sticking there it will clear the edge of the outlet, thus enabling one man to get along very easily. For ½-in. conduit, ⅛-in. wide, No. 19 B & S gauge tape is sufficient. These tapes can also be obtained in sizes of 3/16 and ¼ in. No. 19 B & S gauge, and in standard lengths of 50, 75, 100, 125, 150 and 200 ft.—J. H. L., North Cambridge, Mass.

THE EDISON PIONEERS.

Organization of the Men Connected With Thomas A. Edison in Invention and Development Prior to 1886.

An organization was effected in 1918 known as Edison Pioneers, the object of which is to bring together the men who were associated with Thomas A. Edison in his earlier work of invention and experimentation and to perpetuate the memories of those pioneer days. The membership of the Edison Pioneers is limited to persons associated with Mr. Edison or connected with his work prior to and inclusive of the year 1885. The officers of this association are as follows:

President, Francis R. Upton.

Vice-presidents, S. Z. Mitchell and T. Commerford Martin.

Historian, William H. Meadowcroft.

Treasurer, Frederick A. Scheffler.

Secretary, Robert T. Lozier, 32 West 40th street, New York.

Among the membership, comprising about one hundred persons, are the following well-known electrical men, in addition to the officers named: Dr. Edward G. Acheson, W. S. Andrews, John I. Beggs, C. A. Benton, C. S. Bradley, Col. H. M. Byllesby, Charles L. Edgar, Charles L. Eidlitz, W. E. Gilmore, Edwin T. Greenfield, John W. Howell, Wm. J. Hammer, F. S. Hastings, Samuel Insull, Alfred W. Kiddle, J. W. Lieb, Geo. F. Morrison, Frederic Nicholls, John G. Ott, Charles R. Price, Louis Rau, Frederick Sargent, Charles Wirt, Edwin R. Weeks and Dr. S. S. Wheeler.

PROPOSED RATE CHANGES MUST BE CONSPICUOUSLY POSTED.

In a decision of the Public Service Commission of Pennsylvania it was held that any changes of rates, after being authorized by the Commission, must be conspicuously posted in a manner that shall plainly state the exact changes proposed, whether they are an increase or decrease, and when the proposed changes are to become effective. The question arose because a power company had posted an increased rate schedule in its private office, but this was not readily accessible to its customers. Although the higher rates had been approved, the Commission held that insufficient notice had been given to the patrons and therefore ordered it to restore its former rate schedule.

CORRECTION.

In the Questions and Answers section that appeared in the ELECTRICAL REVIEW of Nov. 2, 1918, page 709, there were published three answers to Question No. 437 on the protection of insulation of trolley feeders. In the sixth line from the end of the second answer appeared the clause, "being sewed or wound with sewing-twine," instead of "being served or wound with serving-twine." This typographical error, overlooked on the page proof, has been called to our attention by W. F. Perry, of Atlantic, Mass., who submitted the answer.—[Ed.]

New Appliances

New Electric Soldering Iron Used for Soldering Bread Cans—New Departure in Design of Portable Lamp Guards

New Electric Can-Soldering Iron.

Several months ago a large biscuit manufacturer was pressed to meet the Government's schedule of hard bread which he was supplying. The difficulty lay not in producing the bread, but in soldering the tin containers for the loaves. This hard bread is packed in small square tin cans and in order to expedite the soldering of the tops the manufacturer mounted approximately 150 standard soldering irons in a horizontal position, along a work bench and instead of the usual type of tip he mounted a large steel square crosshead or clamp on the threaded stud at the end of the iron body, and under this

Electric Can-Soldering Iron for Sealing Cans Containing Hard Bread.

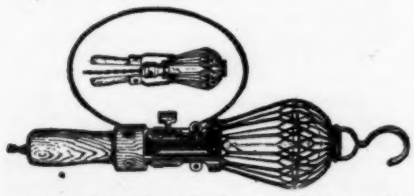
he placed a piece of bar copper vertically at the end of the iron. The cans were soldered by placing them against this piece of copper bar. However, so much heat was dissipated between the heating element and the point of contact with the can that the operators could not maintain any speed at soldering. The manufacturer then wrapped the body of the iron with asbestos, which increased the temperature at the tip but shortened the life of the iron. As the irons burned out he sent them back to the manufacturer for repairs. Having such an unusual number of irons coming in for repairs caused the manufacturer, the Cutler-Hammer Manufacturing Co., Milwaukee and New York, to investigate the conditions under which the irons were being used.

The result was the special can-soldering iron shown in the accompanying illustration. It consists of a pair of heating units which are insulated with mica and then covered by a steel jacket which is pressed into close contact with the mica by hydraulic pressure. The heating units are placed on either side of a piece of bar copper and gripped between two iron plates forming a clamp for the bar copper. A suitable bracket for mounting the iron vertically is also fastened to the clamps. The copper bar used is from 1 to 1½ in. wide and from ½ to ⅜ in. thick. The two heating units work independently of each other and in case of a burnout may be renewed separately. These units have been manufactured by the Cutler-Hammer company for some time and are known as type "H" units; however, for the can-soldering appliance a modified construction is used to provide the proper protection against the fumes of the soldering flux, which in some cases is killed muriatic acid. The flat copper bar conducts the heat rapidly from the two flat heating units and a very small percentage of the heat is lost by radiation or convection. Tests have shown that this new iron with a rating of 200 to 225 watts is capable of doing as much work per hour as a 400-watt standard soldering iron. The new iron is designed for mounting on the bench, but it is possible to furnish a special handle so it can be used as a hand tool if desired. Using this iron, 150 operators averaged 1000 cans per day each, which was considerably in excess of the number they were able to do with any other method.

New Feature in Portable Lamp Guards.

A new departure in portable lamp guards is shown in the accompanying illustration of the Flexco split handle, which can be quickly attached to the Flexco expanded steel lamp guards made by the Flexible Steel Lacing Co., Chicago.

This portable device successfully fills a demand for a substantial handle



Flexco Split-Handle Lamp Guard and View Showing Method of Applying It.

guard which does not need to be wired. The halves of the guard, including the handle itself, open wide from the hinge at the bottom of the guard and can instantly be closed and locked around the socket at the end of any extension cord. The cord itself runs through grooves in the handle.

The convenience of this new product will be appreciated by the motorist in his garage as well as in every factory, mill or warehouse, because it permits a light to be safely carried to dark corners. Fire danger is avoided and lamp users readily perceive the advantage and economy of the guard, as its modest cost is quickly repaid through prevention of lamp breakage.

Latest Approved Fittings

The electrical fittings listed and described in this department have been approved by the Underwriters' Laboratories, Incorporated, after examination and tests conducted under standards of the National Electrical Code as recommended by the National Fire Protection Association.

Conduit Boxes — Marine.— Benjamin Electric Manufacturing Co., 120-28 South Sangamon street, Chicago, Ill.

"Benjamin." Catalog Nos. 6900-03 inclusive, 6908-11 inclusive, 6913.

With cover and gasket. Catalog Nos. 6700-03 inclusive, 6705.

Boxes, complete with connecting block, Catalog Nos. 6706-07.

Covers, Catalog Nos. 6920-24 inclusive, 6926-27, 6930, 6931, 6946.

Gaskets, Catalog Nos. 6945, 6947-49 inclusive.

Listed Oct. 28, 1918.

Current Taps.—The Arrow Electric Co., Hartford, Conn.

"Arrow E." Series or multiple types, Catalog Nos. Ra, RB, RE, RG; adapters, standard to Edison, Catalog Nos. RC, RG.

Listed Nov. 15, 1918.

Current Taps.—The Bryant Electric Co., Bridgeport, Conn.

"Bryant" or Perkins." Multiple type.

Keyless, 660 watts, 250 volts, Catalog Nos. KH, MH.

Listed Sept. 13, 1918.

Current Taps.—The Cutler-Hammer Manufacturing Co., Milwaukee, Wis.

"C-H." Multiple type, keyless, 660 watts, 250 volts, Catalog Nos. 7770, 7771 (has cap. 7702).

Listed Sept. 11, 1918.

Fixtures—Marine.—Benjamin Electric Manufacturing Co., 120-28 South Sangamon street, Chicago, Ill.

"Benjamin." Bulkhead, deck, wall and portable fixtures. Catalog Nos. 6800-03 inclusive, 6810-17 inclusive, 6820-27 inclusive, 6830-33 inclusive.

Portables, Catalog Nos. 6840-41.

Listed Oct. 28, 1918.

Ground Clamps.—Charles M. Rose Co., 136 Prince street, New York, N. Y.

"Xtender." Copper strap having same section as clamp and punched rivet for attachment thereto in extending length of clamp for use with larger conduit.

Listed Oct. 3, 1918.

Heaters — Cooking Appliances. — Globe Stove & Range Co., Kokomo, Ind.

Ranges, hot plates and ovens, 10,000 watts or less, 110-220 volts. Type D-2.

Listed Sept. 25, 1918.

Heaters—Electric Hot-Pad.—Hotpoint Division, Edison Electric Appliance Co., Inc., Ontario, Cal.

"Safety Comfo" heating pads consisting either of a flat round rigid aluminum enclosure or flexible hinged metal unit casing containing heating element in series with a thermostat adjustable between certain limits from outside; and automatic enclosed fusible cutout which operates in event of possible overheating.

"Hotpoint," 100-125 volts, 40 watts, Catalog No. 50151.

Listed Sept. 25, 1918.

Motion-Picture Machines.—Enterprice Optical Manufacturing Co., 564 West Randolph street, Chicago, Ill.

"De Luxe" motor-operated type, provided with complete film enclosure from magazine to magazine, 55 amperes, 110 volts, Catalog No. 1002-E.

Equipped with special 1/6 hp., 125-volt mtors, supplied by Enterprise Optical Manufacturing Co., and expressly accepted for the purpose.

Listed Nov. 15, 1918.

Outlet Bushings.—Multi Electrical Manufacturing Co., 703 Fulton street, Chicago, Ill.

"Powerlet" bushings made of cast iron and threaded for connection to rigid conduit with porcelain cover having outlets for conductors.

Straight, Type A; 45°, Type B.

Listed Oct. 12, 1918.

Picture-Machine Appliances—Reel Indicator.—E. W. Hulett, 4831 North Claremont avenue, Chicago, Ill.

"Hulett." Device designed to ring gong as signal that reel from which film is being unwound is nearly empty.

Listed Sept. 13, 1918.

Receptacles for Attachment Plugs, and Plugs.—The Bryant Electric Co., Bridgeport, Conn.

"Bryant" or "Perkins" Spartan. 660 watts, 250 volts, Adapter, Edison to Sparton, Catalog No. 118.

10 amperes, 250 volts, Cat. No. 112.

Listed Sept. 13, 1918.

Receptacles, Medium-Base — Marine.—Benjamin Electric Manufacturing Co., 120-28 South Sangamon street, Chicago, Ill.

"Benjamin." Composition base.

Key, 660 watts, 250 volts, Catalog Nos. 6966-69 inclusive, G6966-67.

Keyless, Catalog Nos. 6760-61, 6956-60 inclusive, 6980-81, 6986, G6956-58 inclusive, G6986.

Keyless, combined with connecting block, Catalog Nos. 6961-64 inclusive, G6961, G6963.

"Benjamin," non-watertight.

Key, receptacle complete with box and cover, Catalog Nos. 6776-77.

Keyless, receptacle complete with box and cover, Catalog Nos. 6774-75, 6780-81.

Listed Oct. 28, 1918.

Rosettes, Fuseless.—Pass & Seymour, Inc., Solvay, N. Y.

"P. & S.," 3 amperes, 250 volts, Catalog No. 745.

Rosettes with pull-socket mechanisms, 3 amperes, 125 volts, 1 ampere, 250 volts, Catalog No. 740.

Listed Aug. 15, 1918.

Signal Appliances, Miscellaneous.— The Autocall Co., Shelby, Ohio.

Alarm Box, Type M.

Listed Dec. 31, 1918.

Sockets, Medium-Base. — Trenton Electric & Conduit Co., Trenton, N. J.

"T. E. & C. Co." Weatherproof.

Composition, keyless, Catalog No. 156.

Listed Sept. 13, 1918.

Sockets, Medium-Base.—Wirt Co., Armat and Lena streets, Germantown, Pa.

"Dimalite." Extension sockets with two pull chains, 25 watts, 125 volts, Fig. 32.

Listed Sept. 11, 1918.

Switches, Automatic, Pressure-Operated Type.—The Cutler-Hammer Manufacturing Co., Milwaukee, Wis.

"C-H" automatic switch, consisting of contacts operated by springs and levers actuated by pressure variation on diaphragm within chambers attached to switch base; designed to automatically control apparatus for maintaining desired pressure. ¼ hp., 110 volts; ½ hp., 220-550 volts; Bulletin Nos. 10001, 10005. 1 to 5 hp., 550 volts or less, Bulletin No. 10003.

"C-H" automatic switch, consisting of contacts operated by float, actuated by variation of liquid level in tank, designed to automatically control apparatus for maintaining desired water level. ¼ hp., 110 volts; ½ hp., 220-550 volts; Bulletin No. 10031.

Listed Nov. 18, 1918.

Switches, Automatic, Pressure-Operated .Type.—General Electric Co., Fort Wayne, Ind.

Automatic switch, consisting of copper contacts operated by springs and levers, actuated by pressure variations on diaphragm within chambers attached to switch base; designed to automatically control apparatus for maintaining desired air pressure.

10 amperes, 250 volts. 20 amperes, 125 volts. Type CR-2925.

Listed Dec. 3, 1918.

Switches, Knife.—The Trumbull Electric Manufacturing Co., Plainville, Conn.

Sheet-metal boxes with combination switches and cutouts. Catalog Nos. 5630-31.

Listed Oct. 8, 1918.

Trade Activities

Conlon Electric Washer to Erect New Factory—Housing Development at South Philadelphia—Special Literature

American Conduit Manufacturing Co., with general office and factory at New Kensington, Pa., announces the appointment of R. S. Wakefield as its representative for the sale of rigid conduit in the states of Texas and Oklahoma. Mr. Wakefield will make his headquarters at 1312 Great Southern Life building, Dallas, Tex.

The Pacific Coast Grinding Machine Co. has under construction a factory at First avenue South and Lander street, Seattle, Wash., for the manufacture of wrenches and other tools. The equipment, which has been ordered, will comprise grinding machines and special shop tools required for the class of work indicated. All machines and tools will be motor driven, with arrangements for the individual drive in most cases. Gerhard Pearson, son of Alexander Pearson of the Pearson Construction Co., is at the head of the concern.

Wheeler Condenser & Engineering Co., of Carteret, N. J., announces it has obtained from the Schutte & Koerting Co., of Philadelphia, through the Alien Property Custodian, the exclusive right to manufacture and sell steam jet air pumps under patent No. 968,926 in connection with surface condensers, jet condensers, barometric condensers, vacuum pans and evaporating apparatus. This patent covers the valuable feature of two or more steam jets working in series with a condenser between the jets—a feature that enables this type of pump to perform a given duty much more efficiently than any steam jet not so equipped. Upon request test data and full information will be sent by the Wheeler Condenser & Engineering Co.

Conlon Electric Washer Co., Chicago, manufacturer of washing machines for the Western Electric Co., has completed negotiations with David S. and Donald R. Wegg, trustees of the Grant Land Association, for the purchase of 218,000 sq. ft. of land, for a consideration of $32,000. This property is located on the Baltimore & Ohio Chicago Terminal Ry., on South 52nd avenue in Cicero about 300 ft. north of West 19th street. The Conlon company expects in the near future to erect a $350,000 manufacturing plant on this newly acquired property. Frank D. Chase, Inc., industrial engineer, has already begun the work of erecting the proposed improvements, the first unit of which will comprise 75,000 sq. ft., which will be finished this spring. Two additional units will be constructed later in the year, each unit to have a capacity of 150 machines a day. In addition to washing machines, the company will manufacture other electrical household devices distributed by the Western Electric Co.

The Esterline Co., Indianapolis, Ind., has prepared an eight-page booklet, which covers in a very complete manner the subject of power factor instruments, with particular reference to the Esterline Type "MS" graphic recording instrument. Each and every part of this instrument is described in detail and the advantages of its construction pointed out. Esterline switchboard power factor instruments are designed to meet a wide range of uses, including central stations, substations, isolated and industrial plants.

Delta-Star Electric Co., 2433-2453 Fulton street, Chicago, has prepared Bulletin No. 302, illustrating and describing three-phase low tension equipment up to 600 volts. Various types of wiring supports, plugs and receptacles are listed and numerous views of typical installations of this equipment are shown. The plugs and receptacles described are designed for use with coal handling and elevating machinery in yards, on docks and wharves, in railroad yard or any place where it is desirable to connect a motor plug to consecutive stationary receptacles. A list of Delta-Star bulletins is also included in the bulletin.

Westinghouse Company's Housing Development at South Philadelphia.—Several years ago the Westinghouse Electric & Manufacturing Co. purchased a tract of land at Essington, just south of Philadelphia, on which the company intended to eventually erect a plant for building geared turbines for ship propulsion. This work at that time was done at East Pittsburgh and under normal conditions the new plant would not have been begun for some time. But the declaration of war against Germany changed the situation and erection of the plant became immediately an urgent necessity. Work was begun in the summer of 1917, and in less than a year the Essington plant was completed and began to ship products. Today this manufacturing establishment employs 5,000 persons and during the war was a very important factor in the nation's shipbuilding program.

One of the many problems which arose in the course of this work was that of housing the workmen, and because of the close proximity of the plant to several other large industries, living accommodations which existed within easy reach were inadequate to take care of the vast number of workmen drawn into this vicinity. And thus, the erection of houses for Westinghouse employes was absolutely essential. To meet this urgent need the Westinghouse company formed a separate corporation, known as the South Philadelphia Co., to handle the housing development and deeded to it 90 acres of land suitable for residence purposes near the plant. Clarence W. Brazer, an architect of New York, designed the houses and laid out the grounds. The actual work of building the houses was done by the Shipping Board of the Emergency Fleet Corporation. Two hundred houses and part of the stores are now in the course of erection and nearly half of this number are now completed and occupied. As the Westinghouse plant is not merely a temporary war factory, but is the beginning of a large industrial undertaking, all construction work is of the highest grade. Most of the houses have six rooms, but there are some smaller and some larger ones. They are modern in every respect and will be sold or rented to Westinghouse employes only and carry perpetual restrictions that will always maintain the development as a desirable residential district. Charles W. Mebus, of Philadelphia, is the engineer in charge.

Roller-Smith Co., 233 Broadway, New York City, announces the appointment of James E. Wood as manager of its Cleveland office, located at 711 Williamson building. Mr. Wood assumes the position formerly held by C. S. Ripley. After leaving the Hawley Electrical School of Boston, Mr. Wood spent two years in the electrical contracting business in the East, giving up this line to enter the employ of the Screw Machine Products Corporation of Providence, R. I. Here he was engaged in automatic telephone development work initially and later was associated with the Chicago office of the same concern. He then left to accept a position in the engineering department of the Western Electric Co. at Chicago, remaining in Chicago until the latter part of 1918, at which time he left to engage in Government radio work. Mr. Wood will have supervision of the Cleveland office, which covers the state of Ohio and part of Kentucky. The company also announces the opening of a Detroit office in the New Telegraph building. This office is in charge of C. H. Nicholson, who was formerly connected with the Chicago office of the Roller-Smith Co., and left to enter the Signal Corps. Mr. Nicholson is a graduate of the University of Wisconsin and has been with the company since his graduation with the exception of a short period when he was connected with the General Roofing Co. of St. Louis. The activities of the Detroit office cover the entire state of Michigan and Mr. Nicholson will give special attention to the automobile instrument business in that territory.

Current News

Weekly Record of Construction Activities—Conventions

EASTERN STATES.

Pockingham, Vt.—Bellows Falls Power Co., 50 Congress street, Boston, Mass., is arranging for the erection of a hydroelectric plant on Bridge street in the Bellows Falls section of Pockingham.

Chatham, Mass.—The United States government, Navy Department, has awarded a contract for the construction of the proposed local boiler plant and the installation of the heating system. Coleman Brothers, Chelsea, are the contractors.

Central Falls, R. I.—Bryan-Marsh Electric Works of the General Electric Co., Mill street, is making rapid progress in improvements and alterations in its plant, to cost about $60,000. It is understood that the work will be completed at an early date.

Brooklyn, N. Y.—Announcement has been made by Lindley M. Garrison, recently appointed receiver for the Brooklyn Rapid Transit Co., that application will be filed with the Federal court for authority to issue receiver's certificates amounting to approximately $9,000,000, of which about $3,500,000 will be utilized to increase the power facilities of the corporation, to provide electric energy for the operation of the new type cars now on order, including the erection of additions, etc., to existing power stations; and $4,500,000 to provide for completion of construction work now under way, the purchase of new equipment, rolling stock, etc.

Fulton, N. Y.—Oswego Falls Pulp & Paper Co. has had plans prepared for the installation of a new heating and ventilating system at its plant, to cost about $40,000.

Lima, N. Y.—Fire on Jan. 8 destroyed a large portion of the plant of the Locke Insulator Manufacturing Co., specializing in the production of insulators, with total loss placed at approximately $125,000. It is understood that the company will rebuild in the near future.

Little Falls, N. Y.—H. P. Snyder Manufacturing Co. has completed plans for improvements and alterations in its power house, heating and ventilating systems, to cost about $10,000.

New York, N. Y.—American Balsa Co., recently incorporated with a capital of $1,000,000 to take over the American Balsa Corporation, 50 East 42nd street, and the Welin Marine Equipment Co., Long Island City, is planning to manufacture insulation specialties. The company operates plants at 152nd street, New York, Long Island City and Delawanna, N. J. George S. Lewis is president.

New York, N. Y.—United Electric Light & Power Co., 130 East 15th street, is taking bids for the erection of the proposed brick and concrete motor generator building, about 25x75 ft., to be located at 201st street.

New York, N. Y.—New York State Realty & Terminal Co., Grand Central Terminal, has had plans prepared for the erection of a new extension to the boiler plant at its building at 516-18 Washington street.

Sayville, L. I., N. Y.—The Government, Navy Department, has awarded a contract to the North Atlantic Engineering Co., 150 Nassau street, New York, for the erection of a new addition and alterations and improvements in the existing local radio station. The work is estimated to cost $33,000.

Syracuse, N. Y.—The Commissioner of Parks has recently filed with the city officials recommendations for the installation of a new lighting system in the Hiawatha Lake section of Onondaga Park.

Union, N. Y.—Village board received bids for the village lighting system. As none of the bids was satisfactory all were rejected. The board is still of the opinion that the lighting system could be carried on more advantageously under private management. The board has fixed March 1 as the next date on which bids for the lighting plant will be received. John M. Payne, village clerk.

Bayonne, N. J.—City officials are understood to be considering plans for the establishment of a municipally operated lighting plant. Investigations concerning the proposed plant are under way to determine feasibility, site, etc.

Boonton, N. J.—Board of aldermen is said to be considering the installation of a new fire alarm system throughout the municipality.

Caldwell, N. J.—Borough council has arranged an appropriation of $4000 to be used for municipal lighting purposes for 1919.

Camden, N. J.—Public Service Corporation has had plans prepared for the erection of a one-story building, about 20x40 ft., at Newton avenue, near Federal street.

Dover, N. J.—Davis Electrical Co., 54 Clinton street, has submitted a low bid to the Board of Education at $3500 for the completion of electrical work in connection with the new local high school building. The board is also considering plans for the installation of the first two units of the heating system.

Dover, N. J.—Ulster Iron Works, which recently placed into operation its new rolling mill, about 77x400 ft., is understood to be arranging with the New Jersey Power & Light Co. for supplying additional electric energy for operation, amounting to about 100 hp. in motors.

Gloucester, N. J.—New York Shipbuilding Corporation is planning for the installation of four new boilers at its plant. Contract for the settings has been awarded to Albert Doak, Philadelphia, Pa., at $12,000.

Irvington, N. J.—Irvington Electrical Repair Co. has filed notice of authorization to operate a general electrical contracting and repair establishment at 859 Springfield avenue. Frank L. Kearney, 254 South 21st street, heads the company.

Jersey City, N. J.—Western Union Telegraph Co., Hudson street, has awarded a contract for the construction of a one-story brick office building to be located at 23 Hudson street, about 25x25 ft. C. S. Edwards, 1 Exchange Place, is the contractor.

Newark, N. J.—In arranging a tentative budget for 1919, the city has requested an appropriation of $5200 for the maintenance of the Smoke Abatement Department.

Newark, N. J.—In arranging its annual budget for 1919, the city has requisitioned the sum of $283,705, to be used for municipal lighting purposes.

Summit, N. J.—In arranging its annual budget for 1919, the city officials have requisitioned the sum of $11,000 to be used for municipal lighting purposes for this period.

Harrisburg, Pa.—Harrisburg Light & Power Co. has arranged for a note issue of $210,000 to be used in part for proposed improvements, extensions, etc. The company furnishes light, heat and power to Harrisburg, Steelton and a number of other local communities.

Myersdale, Pa.—Myersdale Electric Light, Heat & Power Co. has filed notice with the Public Service Commission of an increase in its rates for service.

Philadelphia, Pa.—The Government, Navy Department, has awarded contracts for initial work in connection with the installation of four new boilers at the Naval Home, Grays Ferry Road, to cost about $15,000. The department has also had plans prepared for the erection of a new pumping plant and tower at the site.

Philadelphia, Pa. — Considerable new electrical equipment will be required in connection with the construction of the large new five-story reinforced concrete factory building, about 52x108 ft., to be erected at 16th and Hamilton streets, to be used

as an addition to the plant of William Sellers & Co.

Philadelphia, Pa.—The Public Service Commission has granted approval to the plan of the Department of City Transit for the completion of the Frankford elevated system from Callowhill street to Front and Arch streets.

Philadelphia, Pa. — Philadelphia Rapid Transit Co. has broken ground for the construction of the proposed addition to its substation at Frankford avenue and Arrott street. The structure will cost $12,000.

Philadelphia, Pa.—Edgewater Dye & Finishing Co. has awarded a contract to James Warner, 240 North 16th street, for alterations and improvements in the boiler plant at its works, to cost about $5000.

Baltimore, Md.—Bids will be asked for purchasing electrical supplies at an estimated cost of $120,000. Address C. W. Logan, president of the Electric Commission, 315 Courtland street.

Frederick City, Md.—Fire on Jan. 4 destroyed the local substation of the Hagerstown & Frederick Railway Co. at Myerville, near Frederick City, destroying a number of other structures and causing a loss of about $40,000.

Hampton Roads, Va.—The Government, Navy Department, has awarded a contract to John Gill & Son, Cleveland, Ohio, for the erection of a new addition to the local boiler plant, about 92x117 ft. in size.

Fairmont, W. Va.—Monongahela Valley Traction Co. is making rapid progress in the construction and equipment of its large new power station at Rivesville, near Fairmont, on the Monongahela river, to have an initial capacity of 50,000 kw. It is understood that operations will be inaugurated at an early date.

Atlanta, Ga.—The city is considering plans for an appropriation of $70,000 to provide for the construction of a new municipal generating plant. R. C. Turner is city electrician.

NORTH CENTRAL STATES.

Lorain, Ohio.—Negotiations at Lorain have reached a point where arrangements are about to be concluded for the Government to advance the necessary funds to complete the new Edgewater plant to take care of the after-war shipbuilding needs.

Mansfield, Ohio.—The Magnetic Springs Railway, operating between Magnetic Springs and Richwood, is to abandoned after Jan. 1. The line will be offered at public sale. The States Utilities Commission has issued this order based upon proof that the company is financially unable to continue the operation of the road, which, the committee held, makes it unsafe to operate the line in its present condition.

Decatur, Ind.—The Adams county commissioners have granted a franchise to the Pleasant Mills Light & Power Co. to extend a line from the county infirmary to Pleasant Mills and Bobo. The company will supply the citizens with electric current from the Decatur municipal light and power plant.

DATES AHEAD.

Northern White Cedar Association. Annual meeting, Hotel Radisson, Minneapolis, Minn., Jan. 21 and 22. Secretary, N. E. Boucher, 702 Lumber Exchange, Minneapolis, Minn.

Pennsylvania State Association of Electrical Contractors and Dealers. Next meeting, Hotel Adelphia, Philadelphia, Jan. 28. Secretary-treasurer, M. G. Sellers, 1518 Samson street, Philadelphia.

Western Association of Electrical Inspectors. Annual meeting, Chicago, Ill., Jan. 28-30. Secretary, W. S. Boyd, 175 West Jackson boulevard, Chicago, Ill.

Oklahoma Utilities Association. Annual meeting, Oklahoma City, Okla., Feb. 6, 7 and 8. Secretary, H. A. Lane, Oklahoma City, Okla.

Illinois State Association of Electrical Contractors and Dealers. Annual convention, Chicago, Feb. 14 and 15. State secretary, G. A. Engelken, 55 West Harrison street, Chicago.

New Mexico Electrical Association. Annual meeting, Albuquerque, N. Mex., Feb. 17-19. Secretary-treasurer, Charles E. Twogood, Albuquerque, N. Mex.

Wisconsin State Association of Electrical Contractors and Dealers. Annual convention, Hotel Pfister, Milwaukee, Wis., March 24-28. State secretary, John A. Piepkorn, 108 Sycamore street, Milwaukee, Wis.

Wisconsin Electrical Association. Annual meeting, Milwaukee, March 25-27. Secretary, J. P. Pulliam, 1408 First National Bank building, Milwaukee.

Indianapolis, Ind.—A two-story addition to the municipal garage of Indianapolis will be erected at once.

Richmond, Ind.—Hydro Electric Light Co. will make extensive improvements. Address City Engineer D. B. Davis.

South Bend, Ind.—A social center building, to cost $50,000, is to be erected at Notre Dame University.

Vincennes, Ind.—Indiana Power & Water Co. has awarded contracts for $150,000 worth of improvements. It is the intention of this company to supply light and power to the Illinois oil fields by stringing three 33,000-volt wires across the Wabash river, spanning the stream from one of the main streets of Vincennes. The power is to be sold to the Central Illinois Public Service Co., which is to supply territory near Lawrenceville, Bridgeport and Stoey and will also provide the residents along the proposed route with light and power. In addition to supplying light and power for 28 coal mines in the region of Vincennes, the Indiana Power & Water Co. is providing the cities of Vincennes, Bicknell, Edwardsport, Lyons, Switz City, Worthington, Dugger, Sullivan, Jasonville, Bloomfield, Odon, Elnora, Newberry and Petersburg with electrical service.

Springfield, Ill.—The Illinois Public Utilities Commission announced that a public hearing will be held at the commission's office in Chicago on Jan. 14, relative to extensions of gas and electric service to new consumers by public utilities.

Lansing, Mich. — $25,000 street lighting bonds were authorized by vote Dec. 28. Address city clerk.

Beaver Dam, Wis.—The city of Beaver Dam will change present arc lights to 60 candlepower Mazda gas-filled lights.

Beloit, Wis.—The matter of extending ornamental lighted section will come before the council. Consulting Engineer Arthur Sweet, Palace building, Milwaukee, will make plans.

Eau Claire, Wis.—Chippewa Power Co., Inc., has incorporated to acquire and develop water power sites on the Chippewa river and its tributaries. Address P. D. Kline.

Galesville, Wis.—Davis Mill Co., operating a flour mill and electric light plant, contemplates an addition to its power house and the installation of a 100 hp. engine. Address B. W. Davis, manager.

Oshkosh, Wis.—Petition has been presented to the council for an electric light. Address city clerk.

Elk River, Minn.—Engineer J. C. Jacobson, 1135 First National-Soo building, Minneapolis, Minn., has prepared estimates for transmission line to be constructed by the Elk River Power & Light Co. F. D. Waterman, president.

Hibbing, Minn.—The village will erect electric light and power plant, to cost $500,000. The specifications include 1500 kw. Address Charles Foster, manager.

Slayton, Minn.—Slayton Power Co. will install a 75 kw. additional steam unit and will put in steam heating system in the village. F. D. Eddy, manager.

Neola, Iowa.—The town council has authorized a bond issue of $10,000 for electric lighting system.

Altenberg, Mo.—Altenberg Light & Power Co. is planning for the rebuilding of its plant, recently destroyed by fire.

Kansas City, Mo.—Kansas City Light & Power Co., 1500 Grand avenue, will erect an electric substation at 31st and Cherry streets. Address general manager.

Kirksville, Mo.—Frankford Electric Co.'s plant was recently destroyed by fire.

Lowry City, Mo.—C. C. Deafenbaugh is to install the necessary engines and dynamos to give the business section of the town a good lighting system.

Miller, Mo.—The aldermen of the city have granted a franchise for J. P. Alexander to put in a complete electric lighting system. The system to be installed is the Delco.

St. Joseph, Mo.—Electrical engineers from Chicago were here recently for the purpose of investigating the electric power situation with the view to the installation by the packing plants of an independent power plant to supply the packing houses of South St. Joseph. The street railway's plant, which has virtually been out of commission for some time, gives little promise of improvement.

Downs, Kans.—$40,000 electric light bonds have been voted. Address city clerk.

Topeka, Kans.—Three hundred new incandescent lamps, costing the city

$2800, were purchased by the municipal light plant. They will be placed as street lights as soon as the old arc lights wear out.

SOUTH CENTRAL STATES.

Long Beach, Miss.—R. Inglis Manufacturing & Commission Co. will purchase additional electrical equipment.

Benton, Ark.—The city commissioners will improve the electric light system.

Hazen, Ark.—J. D. Cash will establish electric light system.

Covington, Okla.—The city contemplates voting on $40,000 bonds to install electric plant, water works and sewer systems. Address mayor.

Howe, Okla.—The city has approved the issuance of bonds for $5-000 to provide for the completion of improvements in the municipal electric plant.

Kingfisher, Okla.—Bids will be called for in the near future for electrical improvements. Black & Veatch, Kansas City, Mo., engineers. H. M. Cleaver, city clerk.

Yale, Okla.—The city has had plans prepared for extensions in the municipal light and water systems, including improvements in the power plant, power lines, stack, switchboards, engine and boiler equipment, and other work. George B. Gelder is city clerk.

Dallas, Tex.—Plans of the Dallas Railway Co. for 1919 call for the completion of its building program, which is now under way. The program involved the expenditure of $800,000. About half of that sum has now been spent. The remainder is to be spent this year. This is in improvements and extensions.

Hempstead, Tex.—The question of purchasing another modern engine for the city light plant is being considered.

McAllen, Tex.—Rio Grande Public Service Corporation is said to be planning for the installation of new machinery to practically double the capacity of its electric light and water systems. R. F. McCord is general manager.

Pacacios, Tex.—The city council has voted to buy the dynamos and other electric lighting accessories belonging to the late Charles H. Trego. The machinery will be moved to the city water works plant as soon as possible and a 24-hour current may be expected.

Teague, Tex.—The city council at its last meeting granted a franchise to T. L. Childs and associates to build and operate an electric light and power plant in the city.

WESTERN STATES.

Gilman, Mont.—The Commercial Club has appointed a committee to take up the question of an electric light plant with business men.

Kalispel, Mont.—Resolution passed the council providing for 29 lighting districts.

Ronan, Mont.—Flathead Telephone Co. plans to extend its lines to cover all of Mission Valley in the spring. A. H. Stevens is interested.

Fort Collins, Colo.—A bond issue of $100,000 has been voted for the purchase of the local street railway system. An agreement between the Denver and Interurban Railway Co., owner of local lines, for transfer of the Fort Collins system to the city for $75,000 already has been reached. $25,000 will be spent by the city in improvements.

Petersburg, Colo.—Fire recently destroyed the entire power plant at the works of the National Alfalfa Products Co.

Lewiston, Ida.—E. W. Kramer, of the hydroelectric department, and J. W. Gerard, of the logging department, of the U. S. Forestry department, have been at Lewiston investigating as to the feasibility of a dam on Snake river to develop hydroelectric power for operating lumber mills. It is stated that a dam at the proposed site would make possible the development of 50,000 hp.

Hunters, Wash.—The electric light plant destroyed by fire.

Ritzville, Wash.—Guy Arthur and Paul Fowler are manufacturing electric heaters of their own design. It is specially adapted to heating water in tanks. Montana Electric Co. are appointed distributors.

Roslyn, Wash.—Roslyn Fuel Co. has doubled the capacity of its coal washer, giving now a capacity of 600 tons of coal per day. This washing plant is built after the design of A. F. Blair, engineer, Seattle. All equipment, both old and new, is electrically operated. An additional crusher and elevator were installed to operate in connection with the new equipment.

Seattle, Wash.—Pacific Northwestern Traction Co., a Stone & Webster organization, which operates the interurban electric railway line between Seattle and Everett, has decided to construct a passenger station at Sixth avenue and Olive street, Seattle, estimated to cost $100,000. The structure will be built by the Puget Sound Traction, Light & Power Co.

Seattle, Wash.—The Capital Issues Committee has recently approved a bond issue for $350,000, the proceeds to be used for the completion of the construction of the loop of the municipal railway at the plant of the Seattle North Pacific Shipbuilding Co., and a bond issue for $200,000 for the East Marginal Way Street Railway, for proposed extensions.

Seattle, Wash.—Puget Sound Traction, Light & Power Co. has had plans prepared for the construction of a new one-story concrete addition at its Jefferson street substation.

Seattle, Wash.—The construction of two gigantic freight yard terminals, one to serve Seattle and Tacoma, and another to be accessible on the north to Seattle and Everett, will be recommended to the State Public Service Commission of Washington. The plan has been developed as a means of relieving the congestion of freight at Puget Sound centers. The engineering phases of the project are being worked out by R. H. Thomson, former city engineer of Seattle. Tentative plans provide for the electrification of all rail lines serving the proposed terminal facilities. Plans also call for additional dock and port facilities of the three cities mentioned.

Spokane, Wash.—Universal Electric Co. has been incorporated in Spokane by C. F. Uhden, A. E. Russell and C. W. Crowders. The plan is to deal in electrical supplies and equipment.

Tacoma, Wash.—A report to city council has been made on the cost of creating a storage basin on East creek, and the data on stream volume. It is figured that the water thus stored would furnish additional power to allow the Nisqually hydroelectric plant to operate at the maximum capacity all the year. It is estimated the additional power thus created would amount to 49,133,000 kw-h.

Victoria, B. C.—The Provincial Government is having plans drawn for a hydroelectric plant to be installed at Squamish, to provide power and light for the P. G. E. terminal at that place, and for lighting the town of Squamish. The project involves the expenditure of $40,000 or more.

Portland, Ore.—Dock Commission opened bids Dec. 30 for electrical installations at Pier No. 1, which showed the following: Smith-McCoy Co., $22,800; Jagger-Sroufe Co., $20,-190; E. L. Knight & Co., $21,173; Ne-Page-McKenney Co., $20,612; National Electric Co., $17,422.

Calexico, Cal.—The city trustees are considering plans for the establishment of a new municipal power plant.

Fresno, Cal.—Contract has recently been awarded by the city to the Lewis Electric Co., Fresno, for the installation of a new ornamental lighting system in South Van Ness avenue. The work is estimated to cost $14,250.

Palo Alto, Cal.—The Board of Public Works has completed arrangements for the installation of a new electric street lighting system in the South Palo Alto section.

Red Bluff, Cal.—The city is having plans prepared for the immediate installation of a new electric street lighting system. E. A. Rolinson, Redding, has been engaged to arrange the plans and specifications.

Porterville, Cal.—Steps are being taken by a number of residents of this city for a petition to the State Railroad Commission for permission to organize here an independent gas company to be financed locally for the purpose of furnishing gas to the consumers of this city and immediate district. Address F. W. Veile.

Riverside, Cal.—Southern Sierras Power Co. is planning for extensive improvements and additions to its plants and system throughout 1919. It is understood that the proposed work will involve an expenditure close to $750,000. The company has recently been granted permission to increase its rates for service by the State Railroad Commission. A. B. West is general manager.

Sacramento, Cal.—It is understood that the city officials are planning to call for new bids at an early date for the construction of the proposed new

electrically-operated pumping plant at the municipal water works.

Santa Barbara, Cal.—The city has had plans prepared for the installation of a new fire alarm system, estimated to cost $14,000.

NEW PUBLICATIONS

Melting Brass in a Rocking Electric Furnace is the title of Bulletin 171 issued by the Bureau of Mines, Department of the Interior, prepared by H. W. Gillett and A. E. Rhoads. The publication contains 131 pages and sets forth in detail the possibilities and limitations of a rocking electric brass furnace. The general problem of electric brass furnaces is discussed and various types of furnaces are compared. Reference to some of the more important articles in scientific and technical publications, dealing with the general subject of electric brass melting and with the performance of various specific types of furnaces, is made in this bulletin in order that interested persons may pursue the subject further. It tells of the present need for this type of furnace and points out the theoretical advantages of electric brass melting. The price of this valuable publication is 20 cents and copies may be secured by addressing the Superintendent of Documents, Government Printing Office, Washington, D. C.

The Decrease in Ultra-Violet and Total Radiation with Usage of Quartz Mercury Vapor Lamps is the title of Scientific Paper No. 330, issued by the Bureau of Standards, Department of Commerce. In this paper experimental data are given on the decrease and intensity of the ultra-violet and of the total radiation with usage of quartz mercury vapor lamps. The measurements were made with a termopile and a yellow (novial shade B) glass. Quartz mercury lamps, the Cooper Hewitt and the R. W. V. Lamp Co. were examined. It is shown that there is no marked difference in the percent of ultra-violet emitted by these lamps when new. The total intensity, as well as the ultra-violet, decreased to one-half to one-third in 1000 to 1200 hours. Comparative data are taken on the ultra-violet component in the radiations from the sun and from the quartz mercury vapor lamps; also data on the dye fading carbon arc lamp. Copies of this bulletin may be secured by addressing a request to the Bureau of Standards, Washington, D. C.

Standards of Mass.—The Bureau of Standards has issued Circular No. 3, entitled, "The Design and Test of Standards of Mass." It treats of the types of weights used as standards of mass and of their design, test and adjustment. Information is given relating to the manner of using weights, and a complete routine for their verification, test and intercomparison is developed. Tables facilitating the comparison of tolerance and precision of corrections, and the computation of corrections, are included. Those interested may obtain a copy by addressing a request to the Bureau of Standards, Washington, D. C.

INCORPORATIONS

Evansville, Ind.—Evansville & Ohio Valley Railroad Co. has been incorporated with a capital of $1,500,000. The company is a reorganization of the Evansville & Eastern Electric railway, William H. McCurdy, of Evansville, director.

Philadelphia, Pa. — Hydroelectric Finance Corporation. Capital $100,000. To finance and operate public utilities. Incorporators: F. R. Hansell, F. M. MacFarland, and J. Vernon Pimm.

Newark, N. J. — Niagara-French Battery Co. Capital, $125,000. To manufacture batteries and kindred appliances. Incorporators: Herbert M. Lloyd, Montclair; Raymond E. Cook, and Ransom Noble, 2304 West 77th street, New York.

Washington, D. C.—Federal Storage Battery Co. Capital, $100,000. To manufacture storage batteries. Incorporators: Rudolph Uramboug, M. E. Jones, and Richard Bowen, Washington.

New York, N. Y.—Save Electric Corporation. Capital, $200,000. To manufacture electrical appliances, etc. Incorporators: M. Ettinger, M. L. Newman and B. P. Price, 680 West End avenue.

Wilmington, Del.—Renew Electric Lamp Co. Capital, $100,000. To manufacture electric lamps. Incorporators: A. M. Fox, Charles R. Bishop, and S. H. Bavard, Jr.

New York, N. Y.—Electric Scaling Co. Capital, $100,000. To construct and operate a ship repair plant for electric cleaning of vessels and kindred work. Incorporators: O. C. Olsen, G. Sunseth, and P. Baumer.

Buffalo, N. Y. — Sentinel Motor Corporation. Capital, $50,000. To manufacture motors, engines, etc. Incorporators: H. R. Stratemeier, F. C. Bonnet, and H. E. Witmer.

New York, N. Y.—Articles of incorporation for 18 public utility properties have been filed under New York laws, covering, for the most part, public utilities now operated by the Electric Bond & Share Co., 71 Broadway. The charter of each of the different utilities covers a nominal capitalization for New York organization purposes, the companies being as follows, located in different parts of the country: Nebraska Power Co., Omaha, Neb.; Dallas Power & Light Co., Dallas, Tex.; Fort Worth Power & Light Co., Fort Worth, Tex.; Pennsylvania Light & Power Co., Pittsburgh, Pa.; Palmetto Power & Light Co., Lehigh Valley Transit Co., Allentown, Pa.; Phoenix Utility Co., New York; Utah Securities Co., Salt Lake City, Utah; Texas Power & Light Co., Waco, Tex.; Yadkin River Power Co., Raleigh, N. C.; Utah Light & Traction Co., Salt Lake City, Utah; Idaho Power Co., Boise, Ida.; Kansas Gas & Electric Co., Kansas; Lehigh Power Securities Corporation, Pennsylvania; Pacific Power & Light Co., Portland, Ore.; Northwest Gas & Electric Equipment Co., Oregon; Carolina Power & Light Co., Raleigh, N. C.; Asheville Power & Light Co., Asheville, N. C. The incorporators are given as F. B. Odlum, H. M. Durning, and R. T. Woodruff, 257 W. 92nd street, New York.

Philadelphia, Pa.—Iron & Steel Equipment Co. Capital, $50,000. To manufacture electrical devices of various kinds. Incorporators: E. M. MacFarland, J. Vernon Pimm, and F. R. Hansell, Philadelphia.

New York, N. Y.—Electric Chemical Engineering Corporation. Capital, $1,000,000. To engage in electrochemical work. Incorporators: Samuel B. Howard, A. W. Britton and Paul S. Smith, New York.

New York, N. Y.—O. M. Matzen & Co. Nominal capital, $5,000. To engage in a general electrical contracting capacity. Incorporators: R. C. Medl, J. F. Smith, and O. M. Matzen, 176 West Broadway.

Philadelphia, Pa.—Kesting-Kopp-Keyster Co. Capital, $25,000. To manufacture electrical wires, etc. Edward Kramer is the principal incorporator.

Miami, Fla.—Ward Engineering & Battery Co. Capital, $30,000. To manufacture storage batteries, etc. Incorporators: R. E. Ward, R. M. Moffatt, and R. G. Ward.

Eau Gallie, Fla.—Eau Gallie Utilities Co. Capital, $30,000. To operate a local plant for the distribution of electric energy. Incorporators: F. D. Fant, Savannah, Ga., and G. C. Rose, Eau Gallie.

Gettysburg, S. Dak.—Boyle Electric Co. has incorporated with a capital of $100,000 by Frank H. Boyle and others.

Tuscaloosa, Ala.—Tuscaloosa Railway & Utilizer Co. has been chartered with a capital stock of $50,000.

Kimball, Neb.—South Divide Telephone Co., Inc., has incorporated with a capital of $2,000 by August Gadeken.

New York, N. Y.—American Bosch Magneto Corporation. Capital, $2,400,000. To manufacture magnetos, electrical specialties, etc. Incorporators: W. P. Shepard, S. F. Johnson and G. H. Hubner, 42 Broadway.

New York, N. Y.—Eastern Signal & Supply Co. Capital, $51,000. Formed by a consolidation of the Eastern Signal Co., Inc., and the Atlas Battery Co., New York, to manufacture railway signals and other specialties. Incorporators: J. W. Waring, J. M. Mencer and E. M. Deems, 30 Church street.

PROPOSALS

Turbines, Pump Set., Etc.—Sealed bids will be received Feb. 4 for furnishing turbines, pump set, feed water heater and electric light plant for hydraulic grader No. 1820. Further information can be received at the office of the Mississippi River Commission, 1st and 2nd Districts, Customhouse, Memphis, Tenn.

Personal

Walter M. Fagan and C. M. Lindsay Receive Promotions —F. N. Boyer Retires from Active Business—Changes

C. W. KOINER, after serving a period in war work with the engineering section, power department, Emergency Fleet Corporation, looking after technical work and general power problems, has returned to his regular duties as general manager and electrical engineer of the Pasadena (Cal.) light and power works.

WALTER M. FAGAN, sales manager of the Hughes Division of the Edison Electric Appliance Co., Inc., Chicago, has been appointed sales manager of the Hotpoint Division of the company. Mr. Fagan was born and reared in California. He was engaged in the electrical business on the Pacific Coast for ten years, about six years of which time was spent in the jobbing business. He later came to Chicago and became connected with the Crouse-Hinds Co., manufacturer of conduit fittings and electrical specialties. After several years of service with this concern he resigned to accept the position of sales manager with the Hughes Electric Heating Co. About a year ago, when this company merged with the heating appliance divisions of the General Electric Co. and the Hotpoint Electric Heating Co., Mr. Fagan remained in charge of the Hughes Division of the new organization.

F. N. BOYER, district manager of the General Electric Co. at St. Louis, after more than 28 years of continuous service with the General Electric Company, has retired from all active business. Older men in the electrical industry will remember Mr. Boyer as general manager of the Reading Electric Light & Power Co., from 1884 to 1891 and as incandescent lamp specialist under John I. Beggs for the Edison General Electric Co. in Chicago in 1891. Mr. Boyer was born at Reading, Pa., September 9, 1855. Thirteen years later he entered the employ of the Philadelphia, Reading & Pottsville Telegraph Co. as messenger boy and in 1869 was promoted to telegraph operator. He was wire chief in charge of all telegraph wires of the Philadelphia & Reading Railroad Co. from 1884 until 1891, when he entered the employ of the Edison General Electric Co. On Feb. 1, 1892, Mr. Boyer was appointed manager of incandescent lamps and of the wire and cable department. A few months later when the General Electric Co. was organized, taking over the Edison G-E Co. interests, this position was abolished and he worked for the supply department of the new company in various capacities. In 1895 he was appointed manager of the supply department and in 1908, on the retirement of B. E. Sunny as manager of the Chicago district, and the appointment of Mr. Johnson as his successor Mr. Boyer was appointed assistant district manager and in 1912 he was made district manager of St. Louis. Throughout the entire General Electric organization and the electrical industry in general, Mr. Boyer's name and personality are familiar.

CARL H. WILSON, first vice-president and general manager of Thomas A. Edison, Inc., with headquarters at West Orange, N. J., has requested an indefinite leave of absence due to ill health. Mr. Wilson has been connected with the Edison interests for the past 21 years.

WALTER F. CROSLEY, who for several years was general manager of the Cairo Railway & Lighting system, has been appointed assistant to General Manager H. E. Chubbuck, vice-president of the Illinois Traction System, Peoria, Ill. The Cairo properties are subsidiaries of the Illinois Traction System.

J. A. WELLS, of the service department Westinghouse Electric & Manufacturing Co., East Pittsburgh, has established headquarters at Ellensburg, Wash., while engaged as inspecting engineer for that part of the equipment being furnished by the company to Chicago, Milwaukee & St. Paul Railway in its Cascade electrification.

C. M. LINDSAY, general manager, Hotpoint Division of the Edison Electric Appliance Co., Inc., Chicago, has been appointed manager of the new sales promotion and advertising department. This department has been inaugurated by the company for the sole purpose of building up its sales service with its customers to the highest possible degree. His long service and extensive experience with the Hotpoint organization have eminently fitted Mr. Lindsay for the position, and the company is indeed fortunate in his appointment in this capacity. His many friends throughout the industry will be glad to learn of his promotion.

H. W. CLAPP, general manager of the Columbus (Ohio) Railway, Power & Light Co., has been promoted to the position of general superintendent. Mr. Clapp was born in Australia and four years before coming to this country was superintendent of motive power of the Brisbane Tramways. In 1902 he became connected with the General Electric Co. as engineer in the New York territory, and during his five and one-half years' connection with the company was intimately associated with the electrification of the New York Central Railroad. Resigning his position with the General Electric Co. Mr. Clapp entered the electrical engineering department of the Southern Pacific Railroad and after four years' service became assistant electrical engineer in charge of construction of the Trans-Bay Electric lines of the Southern Pacific Co., leaving this company to become general superintendent of the Columbus system.

CARL F. HANSON, who has been associated with the Bureau of Standards during the past five years, has became associated with the Habirshaw Electric Cable Co., Inc., of New York City. Mr. Hanson is in charge of research work of an electrical nature.

LIEUT. GEORGE A. MCKINLOCK, JR., liason officer on the staff of Maj.-Gen. B. B. Buck, and a son of George A. McKinlock, Sr., president of the Central Electric Co., Chicago, whose death was recorded in a recent issue of ELECTRICAL REVIEW, has been recommended for the Distinguished Service Cross. The following is a communication from Maj.-Gen. Buck to the Commander in Chief, American Expeditionary Forces (through the War Department) France, recommending Lieutenant McKinlock for the award of this medal:

"(1) I desire to recommend Second Lieut. George A. McKinlock, Jr., deceased, for the award of the Distinguished Service Cross for his conduct in the battle of Berzy-leSec on July 21, 1918, as follows:

"Second Lieut. G. A. McKinlock, Jr., Intelligence Officer, Second Brigade. For exceptional gallantry under heavy artillery bombardment and severe machine gun fire in proceeding along the front lines near Berzy Le Sec to verify the position reports of the advanced locations of the front lines, and was killed while so doing.

"(2) In addition to the foregoing, Lieutenant McKinlock accompanied me between the hours of 2:00 a. m. and 4:30 a. m. on July 21, 1918, on a very perilous expedition along our front lines in the immediate presence of the enemy, where I went to deliver in person the orders and make the explanations of the battle which was to follow that morning. Also, for his gallantry in staying at the advanced telephone post in a little ravine during several hours that morning, attending to his duties as Brigade Intelligence Officer, the location of the advanced telephone being well forward, known to the enemy, and subjected to heavy shell and shrapnel fire during the entire time.

"(3) This recommendation for the Distinguished Service Cross has not been submitted at an earlier date for the reason that Lieutenant McKinlock's body was never found, to my knowledge, and I have waited for the development of the possibility that he might have been carried off as a prisoner by the enemy."

Obituary.

WALTER V. TURNER, Pittsburgh, Pa., manager of the engineering department of the Westinghouse Air brake Company, and a well-known inventor, died on January 9, in his fifty-second year.

RICHARD J. O'TOOLE, inventor of the electromagnetic crossing signal for protecting highway crossings of railways, died recently at his home, Thurmont, Md., aged 71 years.

For the Reconstruction Period—What?

XX.

He Who Hesitates

I have no word of criticism for the manufacturer who—facing a period of business uncertainty—marks time for a month or two before deciding upon a definite policy of production, advertising and sales. He may be one who placed his every resource at the disposal of the Government, who, to hasten the output of vital war supplies, took verbal contracts which are still unvalidated, who accumulated stocks of raw material which cannot be utilized for his regular commercial lines, or who brought about changes in his plant and personnel that are now a source of serious embarrassment.

That man is a hundred per cent American. Neither his motives nor his judgment can be questioned.

But, in justice to his business, to his associates and to his employes, he cannot stop there. He must go forward the instant the way becomes clear. Hesitation too far prolonged is fatal. Indecision paralyzes industry. A lost grip is hard to regain. For his own good, for the common good, let each manufacturer lay his plans for the coming year as soon as possible, and act with the utmost vigor in carrying them through.

C. A. TUPPER, - - - *President*
INTERNATIONAL TRADE PRESS, Inc.

Financial News

Capitalization of Public Utilities.

In the report of O. B. Wilcox, chairman of the Committee on Public Service Securities, Investment Bankers' Association of America, he says:

"In the early days of commission regulation, the commissions, charged under the law with the duty of fixing fair and just rates for service, in the search for their true functions reflected in many of their decisions the demands of the public for cheap service, by so reducing the rates in many cases that appeal was had to the courts to protect investment from confiscation, and it was doubted whether the moral obligation of the state to invested capital and its constitutional protection would prevent its impairment in public service. Gradually the regulatory bodies in many states have come to recognize the growing demands of increasing and sometimes congested population and rapidly expanding industries of the country for increasing public service, controlled by the state but dependent on the investment funds of the country for the capital needed for constant growth; that capital would flow into public utilities in competition with other opportunities for safe and profitable investment in unregulated industries, only if protected and remunerated; and that the chief interest of the state and the public served is in adequate and efficient service rather than in cheap and inefficient service. These principles have been recognized by so many of the public service commissions in all parts of the country during the last year that they may be said to be fairly well established."

The writer then quotes from holdings handed down in recent commission and court decisions:

"The principles recognized by these decisions and their general application in public utility regulation must insure to these securities a protection not afforded any other class of private enterprise; not only are investments in public utilities protected by the constitutional provision against taking property without just compensation and by the moral obligation of the state to protect invested capital and promote enterprises upon which the industries of the country in war and peace are so dependent, but also it is now appreciated and publicly declared that the interests of the state and of the public are served and promoted by permitting rates which are sufficient both to insure adequate service and to create such credit for the operating companies as will attract the necessary capital to provide for the upkeep of the properties and their expansion; and thus private investment in public utility securities is protected in principle not only by the law, but by the recognized interests of the state, the community and the public served.

"While these principles have been so widely recognized by many commissions in recent months, and increased rates have been granted many companies, the increases in rates to the utilities of the country as a whole by no means have equaled the increases in the costs of operation resulting from high prices of fuel and materials and high wages. The development of commission regulation and the appreciation of its obligations to the public to encourage efficient service must operate to increase rates too low to protect investment or attract additional capital for public utility expansion."

Pacific Power & Light Bonds Sold.

Lumbermen's Trust Co., Portland, Ore., has purchased first mortgage 5% bonds of Pacific Power & Light Co. amounting to $350,000. This is a portion of an issue of $1,263,000 of bonds of the latter company, which mature Aug. 1, 1930. The proceeds of their sale are to take up two-year, 6% bonds maturing in 1920. The company operates several hydroelectric stations and 502 miles of high-tension transmission lines, and also operates a number of steam-electric plants. It is given out that net earnings for the year ended Nov. 30, 1918, amounted to almost double the interest charges on all outstanding bonds.

American Telephone Financing.

Officials of the American Telephone & Telegraph Co. are arranging for the issuance of $40,000,000 five-year 6% notes, to provide for outstanding indebtedness maturing Feb. 1, and an issue of $25,000,000 30-year 6% debentures of the New York Telephone Co., a portion of the proceeds to be used for new extensions, betterments and the purchase of new equipment, etc.

Cities Service Co. Bonds Offered by Syndicate.

A syndicate headed by Henry L. Doherty & Co. and Montgomery & Co. is offering at 100 and interest $10,000,000 Cities Service Co. series C 7% convertible gold debentures. These debentures are convertible on and after Jan. 1, 1921, into nine shares of Cities Service Co. preferred stock and one share of Cities Service Co. common stock from Jan. 1, 1919, to the accumulated cash and stock dividends on one share of Cities Service Co. common stock from Jan. 1, 1919, to the date of conversion.

Electrical Operations Show Increase.

Satisfactory results are reported by R. L. Baker, engineer for electrical operations of Henry L. Doherty & Co., in a report on November electric operations. Mr. Baker said that "results of November electric operations from companies so far reporting are very promising, and the net earnings show a large increase over November, 1917, and a very substantial increase over October, 1918. There has never been any trouble with the gross earnings; and as for securing additional business, it is apparently a question only of getting capacity to handle it. From this time on decreased operating expenses should contribute to increased net earnings."

Earnings.

ILLINOIS TRACTION CO.

For the 11 months to Nov. 30—Gross, $13,446,064, increase 9.53%; net, $3,665,596, decrease 11%. November gross, $1,343,654, increase $100,588, or 8.09%; net, $377,719, increase $89,073, or 30.85%.

NORTH CAROLINA PUBLIC SERVICE

	6 months to Sept. 30, 1917.	1918.
Gross earnings	$300,309.41	$347,057.70
Operating expenses	165,663.29	189,446.43
Taxes	9,300.00	7,200.00
Net earnings	$125,346.12	$150,411.21
Interest charges	81,017.60	85,532.50
Net to surplus	$ 44,328.52	$ 64,878.71
Per cent electric light and power business		49.8
Per cent gas business		29.3
Per cent railway business		20.9

Dividends.

American Light & Traction Co. has declared a quarterly dividend of 2½%, also a quarterly dividend of 1½% on preferred stock, payable Feb. 1 to stock of record Jan. 15.

Illinois Northern Utilities Co. has declared a quarterly dividend of 1½%, payable Feb. 1 to stock of record Jan. 20.

Milwaukee Electric Co. has declared a quarterly dividend of $1.60 on preferred stock, payable Jan. 31 to stock of record Jan. 20.

The board of directors of Miami Copper Co. has declared a dividend of $1 per share for the quarter year ending Dec. 31, on the capital stock of the company, payable Feb. 15, to stockholders of record at the close of business on Feb. 1.

BID PRICES OF SECURITIES OF LEAD-WEEKLY COMPARISONS OF CLOSING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeller & Co., Rookery Bldg., Chicago.

Public Utilities—	Div. rate. Per cent.	Bid Jan. 7.	Bid Jan. 14.
Adirondack Electric Power of Glens Falls, common	6	14	12
Adirondack Electric Power of Glens Falls, preferred	6	68	71
American Gas & Electric of New York, common	10+extra	98	98
American Gas & Electric of New York, preferred	6	43	43
American Light & Traction of New York, common	..	243	244
American Light & Traction of New York, preferred	6	99	99
American Power & Light of New York, common	4	52	53
American Power & Light of New York, preferred	6	74	74
American Public Utilities of Grand Rapids, common	..	..	..
American Public Utilities of Grand Rapids, preferred	7	35	35
American Telephone & Telegraph of New York	..	101	100
American Water Works & Elec. of New York, common	..	6¼	5¼
American Water Works & Elec. of New York, particip	7	13	11
American Water Works & Elec. of New York, first preferred	..	69	66
Appalachian Power, common	..	2	2
Appalachian Power, preferred	7	12	15
Cities Service of New York, common	+extra	295	293
Cities Service of New York, preferred	6	80	80
Commonwealth Edison of Chicago	8	115	117
Comm. Power, Railway & Light of Jackson, common	..	22	19
Comm. Power, Railway & Light of Jackson, preferred	6	42	41
Federal Light & Traction of New York, common	..	8	8
Federal Light & Traction of New York, preferred	..	40	40
Illinois Northern Utilities of Dixon	6	..	..
Middle West Utilities of Chicago, common	2+extra	24	20
Middle West Utilities of Chicago, preferred	6	52	50
Northern States Power of Chicago, common	..	58	59
Northern States Power of Chicago, preferred	ex.div.7	87	90
Pacific Gas & Electric of San Francisco, common	..	47	46
Pacific Gas & Electric of San Francisco, preferred	6	85	85
Public Service of Northern Illinois, Chicago, common	7	90	90
Public Service of Northern Illinois, Chicago, preferred	6	91	91
Republic Railway & Light of Youngstown, common	4	16	17
Republic Railway & Light of Youngstown, preferred	6	52	51
Standard Gas & Electric of Chicago, common	..	12	12½
Standard Gas & Electric of Chicago, preferred	6	32	31
Tennessee Railway, Light & Power of Chattanooga, common	..	2	2½
Tennessee Railway, Light & Power of Chattanooga, preferred	6	13	12½
United Light & Railways of Grand Rapids, common	4	38	37
United Light & Railways of Grand Rapids, preferred	6	70	70
Western Power of San Francisco, common	..	15	17
Tennessee Railway, Light & Power of Chattanooga, preferred	6	63	64
Western Union Telegraph of New York	extra	87	87
Industrials—			
Electric Storage of Philadelphia, common	4	53¼	53¼
General Electric of Schenectady	8	151	149
Westinghouse Electric & Mfg. of Pittsburgh, common	7	41	41
Westinghouse Electric & Mfg. of Pittsburgh, preferred	7	56	55